

COLONY AND PROTECTORATE OF KENYA

Department of Agriculture Annual Report 1929

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DEPARTMENT OF AGRICULTURE
ANNUAL REPORT

1929

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AGRICULTURAL DEPARTMENT STAFF—FEBRUARY, 1930.

ANNUAL REPORT OF THE DIRECTOR OF AGRICULTURE.

FOR THE YEAR ENDED 31st DECEMBER, 1929.

REPORT OF DIRECTOR.

STAFF, ETC.

The principal staff changes are shown in Appendix A.

Apart from promotions, changes in the personnel of existing appointments, and junior posts, the staff was strengthened during the period under review by the appointment of five Assistant Agricultural Officers (one temporary), one Assistant Entomologist, and four Coffee Inspectors.

The unit strength of the Veterinary Divisions remains the same. Lt.-Col. Doherty resigned the post of Chief Veterinary Officer, for health reasons, and has been succeeded by Major H. H. Brassey-Edwards. Colonel Doherty rendered valuable services over a period of 23 years, and discharged difficult duties with much credit to himself and the veterinary profession.

Mr. C. C. T. Sharp resigned the post of Chief Grader and Inspector, also for health reasons. In that capacity he had been associated with the Grading and Conditioning Services from their inception, and had shown marked ability in organising them, while he also succeeded in gaining the complete confidence of the producers and commercial community.

Reference was made in my last report to the delay which has occurred in filling new posts. That still continues, with the result that new services sanctioned are generally much in arrear.

This opportunity may be taken of mentioning additional new appointments and services sanctioned for the succeeding year. They comprise : Provision for (a) an Experiment Station on the Coast and an Agricultural Officer in charge ; (b) Locust Research ; (c) a campaign against Striga weed ; (d) Cytological Research on East Coast Fever ; (e) Sea Fisheries

Investigations; one Assistant to Director; one Senior Agricultural Officer; two Agricultural Officers; one Assistant Agricultural Officer; one Agricultural Economist; one Assistant Mycologist; one Soil Chemist; one Entomologist for Coffee Mealy-bug Research; one Entomologist for Tick Investigation; three Veterinary Assistants.

In the discharge of Departmental services, particularly in research and experimental work, more than one branch is not infrequently involved. Steps have accordingly been taken for informal discussions to take place frequently between the responsible officers concerned and the Director, in order to secure collaboration and co-operation and that "team" work which alone can achieve satisfactory results, also to make decisions on important issues.

Notwithstanding the difficulties which have been experienced in building up a Department so technical in character and charged with services so wide in their application, it can assuredly be said that substantial progress along sound lines is being made. With some increase of staff and a steady improvement in the facilities afforded, there has been more than corresponding expansion of services rendered. The sectional reports which accompany this main report furnish ample evidence of the importance and value of the work carried out by technical officers. Where so much remains undone, and where the demands of a young and expanding industry continually faced with new problems and difficulties are met with, every effort has been made to concentrate the available resources upon those activities which are of fundamental importance, and those to which results obtained in research and experimental work are likely to be immediately valuable in their application.

Farmers' Associations and kindred bodies were invited to arrange for lectures and demonstrations to be given by officers of the Department at meetings held under their auspices. The response was gratifying, and several such were held. According as the staff gain more experience of farming conditions in the Colony and are able to base their recommendations upon definite results from experimental and research work, so the educational value of these lectures and demonstrations will gain in importance. Among the subjects dealt with at these meetings the following were the more important: Officers of the scientific and research staff lectured on the diseases and pests of the major crops, including coffee berry disease, *Stephanoderes*, mealy-bug, maize leaf blight and maize head smut, and

other subjects discussed were the proposed special coffee services and the Coffee Research Institute. Officers of the agricultural and field staff lectured on live stock problems, plant breeding (including selection in the field), soil fertility and fertilisers, and general questions concerning cultivation. In the Veterinary Division, additional to the demonstrations given by field officers as a matter of routine and the discussions in which they take part at district meetings, lectures were given by the Veterinary Research staff on rinderpest and rinderpest vaccination.

The outstanding event of importance to the Agricultural Industry, and of interest to the Department, was the appointment of an Agricultural Commission, with the following terms of reference :—

To consider and make recommendations with regard to—

1. The progress of the main branches of the agricultural industry (including native agriculture and stock) since 1920.
2. Factors which tend to retard progress, if any, and the means whereby production may be increased and accelerated.
3. The provision which should be made for augmenting Departmental or other services calculated to advance the industry, and the share, if any, which should be borne by organisations or undertakings representing or concerned with agricultural interests and productions.
4. The formation and functions of advisory, consultative, or other bodies in connexion with the agricultural industry.

As the main purpose of the Commission has been misunderstood, and not infrequently misinterpreted in many quarters, it may be explained that no charge was made in the terms of reference against the Department, and though quite rightly its activities were brought under review, the inquiry was essentially one affecting the whole agricultural industry and not primarily the Department of Agriculture. As Chairman, the Colony was fortunate in securing the services of an outstanding authority upon agriculture and the sciences related thereto, in the person of Sir Daniel Hall. The experience which he brought to bear upon the organisation and execution of technical services stamped the report of the

Commission with that degree of authority and reliability which is of immense value in a country not remarkable for its knowledge and experience in such matters.

The Department is able to note and is glad to record that the chief recommendations of the report were strictly in accord with its aim and efforts for many years past.

FINANCIAL.

Statements of Expenditure and Revenue for the fiscal year under review are given hereunder :—

EXPENDITURE	Amount Originally Sanctioned	Amount Expended
	£	£
Administrative and General (including Total Cost of Headquarters Staff)	23,623	21,152
Native Agriculture	16,067	13,333
Scott Agricultural Laboratories	8,268	8,803
Plant Breeding Services	3,295	3,350
Grading, Conditioning Export Produce	6,278	5,776
Grant to Kenya Agricultural Society	500	500
Contributions to Imperial Bureaux of Entomology and Mycology	450	450
Contribution to Amani Institute	1,930	2,028
Contribution to Imperial Scheme for Agricultural Scholarships	650	649
Contribution to Colonial Agricultural Service	350	175
Contribution to Colonial Agricultural Bureau	..	200
Contribution to Rowett Research Institute	..	2,040
Expenses in connection with Stephanoderes	5,000	3,768
Expenses in connection with Locust Destruction	..	54,924
Assisted Importation of Pedigree Live Stock	1,500	1,295
Ant Repellent	600	780
VETERINARY—		
(a) Executive Division	55,060	52,317
(b) Research Division	32,294	38,161
TOTAL AGRICULTURAL DEPARTMENT £	155,886	209,713

The savings shown are chiefly due to the delay in making new appointments, and the main excesses are due to the special expenditure incurred on locust campaigns, for which no provision had previously been made, also to increased expenditure on the Veterinary Laboratory for the production of anti-rinderpest serum, chiefly for Uganda. This expenditure was covered by the additional revenue derived. In other respects the actual expenditure is closely in accord with the original estimate.

REVENUE	Original Estimates	Actual Receipts
	£	£
Agricultural Produce, Grading, Conditioning and Cold Storage Fees, etc.	6,500	5,418
Sale of Farm Produce and Stock	100	346
Sale of Sundry Stores and Ant Repellent ..	1,100	1,367
Veterinary Inoculation Fees, etc... ..	23,000	21,279
Sale of Sera, Vaccines and Laboratory Products	5,000	18,145
TOTAL AGRICULTURAL DEPARTMENT £	35,700	46,555

The reduction in Revenue under the first item was due to the prohibition of export of the normal surplus of maize on account of famine conditions which occurred in certain native reserves. Reference has already been made to the substantial increase in revenue from Laboratory products.

An analysis of Expenditure and Revenue is given under the following heads :—

(1) Agriculture (other than Veterinary)—

- (a) Headquarters, Administration, Staff, etc. ;
- (b) Research.

(2) Veterinary—

- (a) Executive Division ;
- (b) Services of Veterinary Laboratory.

This statement is exclusive of the expenditure of £54,924 on locust destruction, which was exceptional, and which was not included in the ordinary Departmental Estimates.

	1927	1928	1929
	£	£	£
1. Agriculture (other than Veterinary)			
(a) Headquarters Administration Staff, etc.	15,094	17,038	19,152
(b) Other Services—			
Native Agriculture	9,702	11,547	13,338
Scott Agricultural Laboratories	7,763	8,369	8,803
Plant Breeding Services	2,665	3,379	3,350
Grading, Conditioning and Cool Stores	5,929	5,460	5,776
Grants to outside bodies,	2,750	3,273	6,042
Expenses in connection with Stephanoderes	..	..	3,768
Assisted importation of Pedigree Live Stock	..	815	1,295
Ant Repellent	..	418	787
Gross Expenditure	43,903	50,299	62,311
Revenue	6,953	6,086	7,131
NET EXPENDITURE ON AGRICULTURE (other than Veterinary) £	36,950	44,213	55,180
2. Veterinary*—			
(a) Executive Division	43,690	50,652	54,117
(b) Research	30,088	30,532	38,361
Gross Expenditure	73,778	81,184	92,478
Revenue	27,574	27,707	39,424
NET EXPENDITURE ON VETERINARY SERVICES £	46,204	53,477	53,054
TOTAL NET EXPENDITURE AGRICULTURAL DEPARTMENT £	83,154	97,690	108,434

* These figures include the share of cost of Headquarters Office Services, *e.g.*, Clerical, Accounts, Storekeeping, etc., rendered for "Veterinary." Accordingly £1,800 has been debited to Veterinary (Executive Division) and £200 to Veterinary Research.

It will be noted that the proportion which the net expenditure upon Veterinary Services bears to the total net expenditure of the whole Department has undergone a slight reduction. It now stands at 49 per cent.

GENERAL.

The rainfall during the year was generally above the average. As a consequence, good yields, particularly of cereal crops, were secured. The season was, however, late, and excessive rains, which occurred in some districts during December, impeded harvesting operations, and extensive areas of maize and wheat remained unharvested at the end of the year. The coffee crop was not so high, but the favourable weather conditions prevailing during the year had the effect of restoring vigour to the trees, the benefits of which should be reflected in the yield of the succeeding crop, provided satisfactory rains continue. Both throughout settled areas and native reserves, the crops of 1929 as a whole reached a record volume of production, and only the heavy fall in prices of primary products which took place subsequent to the period covered by this report prevented the Colony from deriving to the full the benefits thereof.

Failure of the short rains of 1928, combined with the depredations of locusts, brought about famine conditions in certain areas, notably in the Meru and Embu Districts, in the early part of the year. Immediate action was taken to prohibit the export of certain native foodstuffs, save under licence, from the Kikuyu Province. After a close examination of the position and consultation with interests concerned, the Director of Agriculture was appointed Licensing Authority, until the Food Control Ordinance, 1929, was enacted. Under it a representative Food Control Board was appointed, and the administration of the Ordinance fell largely on this Department, with the Director of Agriculture as Chairman and Mr. A. C. Hunter, Statistical Officer, as Secretary.

An embargo on the export from the Colony of maize, maize meal and pulse, save under licence from the Food Control Board, was placed, and available stocks of foodstuffs in the Colony were assessed, and arrangements made for their equitable distribution.

Maximum prices chargeable for maize and maize meal were declared. Export licences were issued as far as possible in order to avoid jeopardising the future trade of the Colony, and in September the embargo was raised.

Special issues of seed were made in the affected areas, and supplies of food, at a total cost of Sh. 1,057,965/83 were purchased and delivered by the Board. It became necessary to

import 30,358 bags of maize from South Africa to meet the shortage which existed before supplies from the new crop became available.

A full report of the operations of the Licensing Authority and Food Control Board has been published.

The agricultural conditions and practice in the Colony were reviewed in my last and previous reports. No new factors have come to light, but it may not be inappropriate to emphasise the need for conducting farming operations on sound economic lines with a due regard to keeping down costs of production, so that the Colony may compete successfully on the world's markets, and the importance of maintaining the inherent fertility of the soil, also of improving the productive capacity of the live stock by attention to selection and breeding.

In native areas, where land and labour costs are not at present factors which influence costs of production and where the peoples by their methods of cultivation and opportunities afforded are not faced seriously with a soil fertility problem, the most immediate need is to secure an increased output of marketable crops surplus to their own needs in respect of food, to improve the quality of those crops, and to facilitate marketing arrangements with a reduction of transport costs.

Even within the last decade, knowledge and experience in farming practice in this Colony have made great advancement; to both of these the efforts of private enterprise and Departmental activities have contributed, but it should be realised that there is no "short cut" to the solution of many problems, and inevitably much time will be occupied in dealing with them. In addition to the measures which can be taken by legislation and otherwise for the protection of the industry against pests and diseases, their introduction, and control of their spread, no money can be better spent than upon pursuing experimental and research work, and of translating the results therefrom into practice by educational and other means.

METEOROLOGICAL.

The meteorological services undertaken by this Department were handed over to the East African Meteorological Service on January 1st, 1929, but assistance was rendered in certain important directions until the end of the year. It is desired to take this opportunity of bearing testimony to the co-operation and assistance received from private individuals

and officers of other Departments in rendering meteorological returns regularly to this Department. With that aid and with but slender resources, an efficient service within its limits has been provided by this Department for the last 25 years, and the reports which have been compiled and published regularly have proved of real value in connexion with the development of the Colony. Often the information so furnished has been the best and only means of exercising a judgment upon the resources of a district and its suitability or otherwise for embarking upon the growth of crops new to it, and for determining along broad lines its potential production.

A summary of the meteorological records for 1929 is appended hereto (Appendix W), for which acknowledgments are due to the Director of the East African Meteorological Service.

AGRICULTURAL STATISTICS.

Arrangements have been made by the International Institute of Agriculture at Rome, with the assistance of the Empire Marketing Board, for a World Agricultural Census to be collated in 1930.

The Statistical Branch of this Department has been engaged in adjusting its system to meet these needs, and all preliminary arrangements connected therewith have been made.

It is seen that the methods hitherto adopted and the schedules in use for the Census of European development and production will, with slight amendment, conform to the requirements.

With regard to native agriculture, an endeavour is being made to secure figures of development and production by means of close estimates, which will be furnished by Administrative Officers, in collaboration with Agricultural Officers, as far as circumstances permit.

A further effort is being made to collect data relating to Indian agriculture; a special schedule has been prepared for the use of Indian agriculturists in the coastal area, from which statistics have hitherto not been available.

The tenth Agricultural Census, for the year August 1st, 1928, to July 31st, 1929, was compiled and published.

The following tables and appendices were submitted with the report :—

- (1) Acreage under occupation, under cultivation, and under principal crops.
- (2) Numbers of live stock, the property of Europeans.
- (3) Animal products sold by European occupiers.
- (4) Cereals, total production, area harvested, and yield per acre of cereals (maize, wheat and barley).
- (5) Coffee, acreage planted, age of trees, and yield of " clean " coffee and *mbuni*.
- (6) Tea, area planted, estimated acreage to be planted during the succeeding year, and production of tea.
- (7) Sisal, acreage planted, age of plants, and production of fibre.
- (8) Coconuts, acreage planted, numbers and age of palms, and production of nuts and copra.
- (9) Average number of units of labour employed on agricultural holdings.

CROP REPORTS.

The revised system of forecasting crop production and exports, inaugurated in 1928, was continued during the year with satisfactory results.

The number of Crop Correspondents who assist in this service by submitting monthly estimates was increased to 285. Reports were published in respect of the months of January, February, July, August, September, October, November and December. The thanks of the Department are due and tendered to the Crop Correspondents who regularly and promptly submitted monthly estimates of their crops, and by so doing enabled the Department to maintain this service, valuable alike to Government, Railways and Harbours Administration, Shipping Companies, Trade and Commerce, Agriculturists, and the public generally.

IMPORTS.

The following schedule gives particulars of the imports into Kenya and Uganda of certain products. This statement is of importance in its relation to the development of the agricultural industry, the markets for, and the extent to which they remain unfilled by, local produce.

IMPORTS—KENYA AND UGANDA.

QUANTITY		1929	1928	1927	1926	1925	1924	1923	1922	1921	1920	1914
Wheat ..	... cwt/s.	2,847	3,754	2,904	2,821	2,635	1,993	1,983	900	1,352	337	5,585
Wheat Meal & Flour ..	"	68,665	64,742	63,843	58,257	53,657	48,474	47,699	59,817	78,069	76,823	81,898
Ham and Bacon ..	"	60	93	124	121	58	23	5	9	20	118	701
Butter ..	... lbs.	17,136	16,464	6,132	2,576	2,688	1,120	560	4,032	11,081	3,890	34,997
Cheese ..	"	31,920	29,344	18,032	13,216	3,854	3,248	1,456	1,792	2,561	12,636	38,836
Ghee ..	"	8,910	8,986	10,475	7,099	7,309	8,592	5,233	4,209	1,878	600	2,347
Condensed Milk ..	... cwt/s.	14,018	12,170	8,531	8,009	6,258	5,352	3,105	1,305	4,560	5,210	9,468
Sugar ..	"	48,029	80,244	9,623	19,567	27,161	27,446	31,632	69,212	65,958	47,921	74,485
VALUE												
Wheat ..	£	2,530	3,227	2,694	2,612	2,524	1,623	1,590	£ 879	£ 1,900	£ 515	£ 3,001
Wheat Meal and Flour ..		58,644	57,231	58,739	57,929	56,364	40,790	40,362	63,775	102,025	112,795	52,890
Ham and Bacon ..		710	£ 43	1,253	1,304	641	217	73	117	285	1,368	4,256
Butter ..		1,555	1,624	675	275	283	122	74	412	1,383	515	1,972
Cheese ..		3,146	2,965	1,760	1,397	401	292	180	201	354	922	1,820
Ghee ..		37,164	36,372	46,832	49,838	42,685	28,740	13,717	14,631	13,900	3,510	8,702
Condensed Milk ..		40,310	39,115	27,321	29,132	22,990	20,851	11,912	5,247	25,076	22,554	20,498
Sugar ..		38,56	68,903	10,661	20,265	31,475	42,049	54,041	89,405	129,869	167,554	54,829
TOTAL ..	£	182,645	210,288	149,910	162,752	157,363	134,686	121,949	174,667	274,792	309,733	147,968

In considering this Schedule due regard should be given to the increase in population.

Despite the fact that adequate supplies of Kenya-grown wheat were offering in the Colony throughout the year, an increase in the quantity of wheat, flour and meal imported, though slight, is again recorded. Of the total imported, i.e. 68,605 cwt., 10,065 cwt. were exported to Uganda, and re-exports amounted to 6,977 cwt. By deducting these quantities it is seen that Kenya consumed 51,563 cwt. Railway statistics show that 33,754 cwt. were railed from the Coast to up-line destinations, including Uganda; it would therefore appear that of the 51,563 cwt. consumed in Kenya, 27,874 cwt. were retained at the Coast and 23,689 cwt. consigned to other parts of the Colony. Translated into wheat, this importation of flour, even if entirely displaced, would not provide a market for more than about 20 per cent of the present production of wheat. Though every effort should be made to capture the entire market, it will be seen that the development of the wheat industry should not be dependent upon it.

It will be seen that for all practical purposes this Colony is self-supporting in respect of ham and bacon, butter and cheese. Such quantities as are imported consist chiefly of tinned goods for special needs, e.g. *safari* requirements. The ghee is imported chiefly from Tanganyika. For the manufacture locally of condensed milk, special conditions are required, and the position should be reviewed, as opportunities may occur for the establishment of a factory in a suitable locality where a sufficient supply of fresh milk is assured. Imports of sugar have varied greatly during the last few years, but it would be hoped that, as the industry becomes more firmly established and the production of cane increases substantially, a large proportion of the present imports will shortly be displaced.

EXPORTS.

(Vide *Appendix X.*)

The total value of agricultural exports, the produce of Kenya, in 1929, was £2,372,976, a decrease of £364,272 as compared with the previous year.

The value of coffee exported during the year decreased by £416,736. This more than accounts for the decrease in the total value of agricultural exports.

The tonnage was 90,233 tons in 1929, against 104,519 tons in 1928. This decrease is almost entirely due to the smaller

quantities of maize and coffee shipped during the year. Mention has already been made of the restriction of export of maize early in the year owing to famine conditions, while in the latter months there was also a decrease in tonnage of this traffic exported owing to the lateness of the season.

The statistical information given in the succeeding subsections of this Report relates, except where otherwise stated, to agricultural development by Europeans.

More complete information is to be found in the annual Agricultural Census Report for the year.

ACREAGE, OCCUPATION AND DEVELOPMENT.

The total area allotted for occupation by Europeans is approximately 6,720,080 acres, and in addition an area of about 952,320 acres is still available for alienation. Of the area allotted, 5,000,648 acres are under occupation, showing an increase of 104,242 acres as compared with the preceding year. The number of European occupiers totals 2,035, a net increase of 64 over the previous year, but it is calculated that changes of occupiers took place in 79 holdings, making the number of new occupiers 143.

The number of Europeans employed on agricultural holdings, inclusive of the 2,035 occupiers, is returned at 2,882, an increase of 75 as compared with the previous year. It is recorded that nineteen holdings, previously occupied, were vacated during the year. It is believed that the conditions of drought in certain areas have been the cause of this temporary surrender and that they will shortly be again occupied and developed.

The total area under cultivation is 635,590 acres, giving an average of 312 acres per occupier as compared with 301 and 269 acres for the years 1928 and 1927 respectively. Including land used for stock farming, it is calculated that the area beneficially occupied is, on the average, 1,309 acres per occupier, which shows the extensive character of farming operations in the Colony.

In addition, considerable areas of farms are used by native squatters and employees.

The following comparative table of ratio of acreage under cultivation to total acreage occupied reflects sustained and satisfactory progress.

YEAR	Total occupied area	Total cultivated area	Total area under crops as at 31st July.	Total area cultivated but not planted as at 31st July.	Percentage cultivated to occupied land as at 31st July.	Percentage cropped to cultivated land as at 31st July.	Percentage fallow at 31st July.
1929 ..	5,000,648	635,590	570,171	65,419	11.40	88.69	10.31
1928 ..	4,896,406	592,741	525,421	67,320	11.81	88.64	11.36
1927 ..	4,737,920	512,543	438,035	74,508	10.82	85.46	14.54
1926 ..	4,587,817	463,854	401,041	62,813	10.11	86.46	13.54
1925*..	4,420,573	392,628	342,331	68,297	8.88	82.61	17.39

* The Census period for the year 1925 was 1st July to 30th June.

MAIN CROPS.

On 31st July, 1929, the total area under crops was 580,171 acres, and the total area under cultivation 635,590 acres. For comparative purposes, figures for the previous year are given, together with percentages of increase and decrease in the following table :—

	1929	1928	Increase	Decrease
			%	%
Maize	245,807	215,960	13.8	—
Wheat	66,089	88,429	—	25.3
Barley	14,543	5,933	145.1	—
Coffee	90,205	84,073	7.3	—
Sisal	109,375	91,909	18.8	—
Tea	5,593	4,809	16.3	—
Coconuts	8,568	7,994	7.3	—
Sugar Cane	11,161	9,408	18.6	—
Miscellaneous	28,543	24,384	17.1	—
Total Acreage of Crops Grown	579,884	532,899	8.8	—
Less Catch Crops	9,713	7,478	29.9	—
Net Area under Crops	570,171	525,421	8.5	—

MAIZE.

The figures quoted above show an increase of 29,847 acres, or 13.8 per cent in the total area of 245,807 acres, planted as at 31st July, 1929.

The average yield over the Colony was 5.35 bags per acre, showing a reduction due to unfavourable weather conditions, and in a lesser degree to damage caused by locusts.

The following table showing the acreages and yields of maize in past years is of interest :—

YEAR					Acreage Harvested	Actual Production	Bags per Acre
					<i>Acres</i>	<i>Bags</i>	
1924-1925	..	..	..	..	129,647	893,108	6.89
1925-1926	..	..	..	..	155,751	826,614	5.95
1926-1927	..	..	..	..	177,987	1,314,643	7.39
1927-1928	..	..	..	..	177,009	1,088,706	6.15
1928-1929	..	..	..	..	204,945	1,099,317	5.36

Exports of maize (including native grown) for the season (August-July) increased from 805,081 cwt. in 1927-28 to 912,561 cwt. in 1928-29.

In the earlier years of maize export, a fair proportion of that export consisted of maize of "native" type. Latterly, however, native-grown maize has come to be used largely for local consumption and for export to Benadir Coast ports, thus releasing a larger quantity of Flat White for export to the European markets. Maize of this type is, however, being grown in native reserves in increasing quantities, through the distribution of seed in bulk by the Department; in some cases, as a free issue; in others, from funds provided by Local Native Councils.

Crop estimates for the 1929 planted crop forecast a record total production of two million bags, and it is estimated that about 1,250,000 bags will be available for export overseas. Goods crops from this planting were secured in almost every district and at the end of December it was estimated that the average yield over the Colony would figure at 8.18 bags per acre.

The co-operative experiments recently started on farms have already furnished useful information on soil fertility and treatment in relation to the growing of maize and other crops. A progress report of these experiments was published before the beginning of the last planting season, in order that farmers might have, in due time, information based upon the results of these experiments.

At the Njoro Plant Breeding Station much valuable work on maize has also been done, having a direct bearing upon the best practice to be adopted for securing high yields, the most economical manurial applications, and other problems. Both at that station and at the Scott Agricultural Laboratories, work is being done on maize selection and breeding for the improvement of high yielding types of "flat white" maize, and at the latter institution a variety, "Muratha," is also being fixed and improved for cultivation in native areas. The value of maize selection on farms for such purposes has been urged upon growers, and both through bulletins and by direct explanation they have been taught how the work should be done. Seed of different varieties of maize has been introduced and distributed for trial purposes.

Attention has been given to the selection of a type resistant to *Helminthosporium triticum* (White Blight), and already success has been achieved in securing plants possessing that essential factor as the starting point of further operations in the application of selective methods of breeding and for the multiplication of seed of the resistant type.

A proposal for a maize-growing competition, designed specially to encourage the production of maize fixed in type, of high quality and possessing heavy yielding power, also the supply of reliable seed of better quality, has been submitted to the Royal Agricultural and Horticultural Society, which intends to give effect to the proposal in 1931. It is hoped that this competition may encourage seed selection and production and lead to the formation of one or more Seed Growers' Associations.

The Grain Conditioning and Grading Services continue to perform a valuable and essential service. As evidence of the extreme care exercised in the discharge of the service, no complaints have been made by the trade, either overseas or locally. The grading certificates remain unchallenged and final, and they have established a high reputation.



HARVESTING BARLEY—MT MARGARET ESTATE—AUGUST, 1924

Experience has shown that in some districts, particularly in seasons of good rainfall, difficulties are found in getting the moisture content down to the maximum of 12.5 per cent permissible. Inquiries are still being pursued through the Institute of Agricultural Engineering Research at Oxford in the hope that an efficient drier for use on farms may be found. Maize-growers should, however, endeavour to provide more efficient rain and damp proof maize cribs. On many farms the present provision for the storage of maize leaves much to be desired.

WHEAT.

The area planted as at 31st July, 1929, was 66,089 acres, a decrease of 22,340 acres as compared with the previous year. It is known, however, that considerable areas were sown, particularly in the Machakos District, subsequent to the 31st July. The decrease in the wheat area is due to a change over from this crop to maize and barley, which has been in evidence during the past two years. The total acreage of these crops, however, only shows an increase of 16,117 acres over the previous year. It is believed that this small increase is due to unfavourable weather conditions which prevailed in the early part of the year.

The acreage harvested in each year and the production during the past five years are as follows :—

YEAR	Acreage Harvested	Actual Production
	<i>Acres</i>	<i>Bags</i>
1924-1925	23,996	61,067
1925-1926	30,627	80,069
1926-1927	46,601	120,569
1927-1928	75,102	173,958
1928-1929	82,951	228,141

The December estimate for the 1929 planted crop is given at 347,000 bags, equivalent to an average yield of 5.25 bags of 200 lb. per acre. It is, however, considered that this estimate is somewhat optimistic, and that the average yield will be considerably less. The yield has been lowered through unfavourable weather conditions in some areas at the time of harvesting.

There are indications that average yields higher than those of past years will now be obtained, due to the lessened risk of rust by the introduction of rust-resistant varieties, the application of fertilisers to wheat crops, the growing of wheat on land possessing higher fertility, and a better knowledge of the culture of the crop.

During the year, 69,603 cwt. of wheat, valued at £38,281, were exported, chiefly to Indian and South African markets. In addition, 32,013 cwt. of flour, valued at £31,996, were exported, mainly to Uganda and Tanganyika.

Statistics of wheat-milling operations were called for in respect of the period 1st December, 1928, to 30th November, 1929. The main features of the returns are as follows :—

There were eight wheat mills operating in the Colony during the year. These mills are capable of milling a total of 56 bags (200 lb.) of wheat hourly. 124,356 bags wheat were milled during the year, and produced 33,353 bags (200 lb.) of fine flour and 41,934 bags (200 lb.) of atta flour.

The wastage in milling (pollards, bran, etc.) was 30,915 bags of 200 lb., or 24.8 per cent of the total quantity milled.

The establishment of the wheat industry in this Colony is primarily dependent upon the growing of rust-resistant varieties, for the breeding and raising of which an efficient plant-breeding organisation is essential. The position is an intensely complicated and difficult one. The three main species of rust, viz. *Puccinia graminis* (black stem rust), *Puccinia glumarum* (ear or yellow rust), and *Puccinia triticea* (brown or leaf rust), are present in different districts, in many of which two species are prevalent. In addition, two physiologic forms of *Puccinia graminis* have been determined, and the same variety may not be resistant to both. A considerable advance has been made by the breeding and multiplication of B.286 (Kenya Standard) to the stage when several thousands of acres of it are now in cultivation. This is a "fixed" variety, possessing also good yielding power and high milling quality. It is resistant to both forms of *Puccinia graminis*, and is therefore suited to those districts in which *Puccinia glumarum* is not prevalent. There is considerable promise that success will be achieved in the breeding of varieties which will be resistant both to *Puccinia graminis* and *Puccinia glumarum*, an achievement which will, it is believed, be without parallel elsewhere.

The work of the Plant Breeder has been facilitated and expedited by the research work and testing which is being done by the Mycologist on the different forms of the same species of rust. Further information in regard to the plant breeding services and this work of the Mycologist will be found in the relative sectional reports.

A disease, locally called "glume blotch," a disease affecting the ears, determined as *Septoria nodorum*, causes serious loss in some districts. Further investigation is required before a definite pronouncement can be made upon it.

The wheat grading system, introduced in the previous year and based upon variety, description of grade, and weight per bushel, has worked very satisfactorily, and is already accepted by the trade. Good grades both of "Equator" and "Kenya Governor" are realising satisfactory prices, as compared with standard varieties and grades on the overseas markets.

Wheat has been successfully introduced into certain Native Reserves with the main object of improving the variety and quality of the farinaceous diet of natives. In collaboration with the Medical Department, tests were made on the mixing of wheat and maize meal in the proportion of about 1 to 5 respectively, with entirely beneficial results, and it is not unlikely that such a mixture will become a standard *posho* ration.

BARLEY.

The area under barley, as at 31st July, 1929, was 14,543 acres, compared with 5,933 acres in the previous year, and indications point to still further extension of this crop. An export trade has now been established, 24,798 cwt., valued at £8,679, having been shipped to overseas markets. It has been demonstrated that "malting" barley of good quality can be grown in several districts, though as in other countries the risks of discoloration of grain due to rain and mists must remain.

COFFEE.

Notwithstanding the unfavourable planting conditions which prevailed in the early months of the year, a satisfactory increase in the area planted with coffee is again recorded. The total area under coffee is returned at 90,205 acres, an increase of 6,132 acres over the previous year.

The quantity of coffee produced in the last agricultural census year was, on account of unfavourable weather conditions, low. It amounted to 145,880 cwt. of coffee, valued at

£785,171. The December estimate of the 1929-30 crop was given at 198,173 cwt., or 61,802 cwt. in excess of its fore-runner. For some years past, the general condition of many coffee plantations has suffered on account of a deficiency in rainfall, although this did not actually amount to drought. The more copious and regular rains of 1929 have restored the condition of the trees, their vigour has greatly improved, and, in the absence of unforeseen circumstances, the 1930-31 crops should prove a record one in yield.

To some extent, the lower average yields of recent years have been compensated by abnormally high prices, but it cannot be expected that such prices will be maintained, and, in fact, the value of Kenya coffee decreased towards the end of the year. This is attributable partly to the inferior quality, caused by drought conditions during ripening, and partly to the large quantity of low-grade coffee on the world's markets. Good quality Kenya coffee, however, maintained a high price throughout the year. While there has been a marked advance in cultural practice during recent years, lower prices will inevitably bring about a revision of the values of coffee land, and will cause greater attention to be given to more intensive methods of culture, designed to secure higher average yields, while close regard will have to be given to labour organisation and handling of the crop in preparation for market, in order to keep the costs of production as low as possible.

Coffee planters have, for a lengthy period, spent comparatively little upon the protection of the crop from pests and diseases. In this respect, they have been fortunate when compared with planters elsewhere, but in the future it is not unlikely that sanitary measures will prove to be an important and essential feature of sound coffee management. Coffee-growers are fully alive to the importance of such measures, although they may not always have the means to carry them out, and although the Department may not be in a position to give precise information and advice on every pest and disease which besets. In this regard, knowledge based upon definite research and experimental work is accumulating, and the full resources of the Department are directed towards meeting the demands and needs of the industry, but necessarily time is occupied by such work, and much leeway remains to be made up against the period when the staff was quite inadequate to pursue investigations which should have been carried out in advance of the need. It is gratifying to record that the

majority of coffee-growers have now agreed to contribute towards the cost of the technical and scientific services which the industry requires. The Agricultural Commission made a definite recommendation in support of this principle, which has been advocated by this Department for some years past, and much consideration has been given to the framework and organisation of a scheme for special "Coffee Services."

For the first six months of the year, an Assistant Agricultural Officer was attached to the Coffee Section to assist the Senior Coffee Officer with routine work at Headquarters, and in connexion with the organisation of the *Stephanoderes* campaign. In addition, three temporary inspectors and thirteen temporary assistant inspectors were engaged for the campaign. The means adopted to control this pest were by complete clearing up of all ripe coffee, whether on the trees or on the ground in plantations or around factories, or elsewhere, to ensure that there was a certain period when it could find no breeding place. For the administration of the Rules which were promulgated in 1928 to this end, a thorough inspection of every coffee plantation in the Colony was necessary, and in many cases the powers vested in the Department under the Rules had to be exercised. In two cases only was it necessary to take the matter into the courts, and in each case a conviction was obtained.

The amount of office work entailed in dealing with and collating the reports of the inspectors was considerable, as the opportunity was taken to make a complete survey of coffee pests and diseases throughout the Colony.

Certain points in the Rules were found in practice to be unsatisfactory, and these were cleared up in the Diseases of Plants Prevention (Coffee) (Amendment) Rules, 1929, which came into force in April. The Longicorn beetle, *Sophronica*, was found to be so widely distributed and to be capable of causing so much damage that it was included with *Stephanoderes* in these Rules. The response of certain planters and traders to the Rules governing the movement of coffee has not been as satisfactory as could be desired, and they should realise that such Rules are framed only for their protection.

Further steps were taken to control the spread of the pest by enforcing the inspection of all coffee intended for seed purposes, and 4,970 lb. of such coffee were examined by members of the staff, and passed as free from diseases and pests. The certification of seed implies only such freedom,

and must not be taken as a guarantee of quality, which, it is regretted to record, was on the whole very low. After the main inspection was finished, in order to minimise delays in consigning coffee for seed purposes, honorary inspectors were appointed for seed certification.

The general inspection has enabled a large number of neglected or abandoned plantations to be cleared up, and the removal of these menaces, together with a noticeable improvement in cultural methods directly consequent on the inspection, should prove a great asset to the industry.

The campaign was completed as far as field work was concerned by the end of April, and the staff was gradually reduced until that date, when four temporary inspectors were retained to form a nucleus field staff for future operations. These officers were employed for the remainder of the year on general coffee inspection, although in some cases and for varying periods their services were utilised in connexion with other inspection work.

Circulars concerning a variety of subjects of interest to the coffee industry were sent out, and a memorandum on "The Introduction of New Varieties of Coffee, Plant Breeding and Vegetative Propagation" was prepared.

Experimental work has been continued at the Scott Agricultural Laboratories on different varieties, also in connexion with pruning, seed selection, irrigation, budding and grafting, and shade, both 'natural and artificial. While no crop figures are yet available, it is of interest to note that coffee under artificial shade and under *Gliricidia maculata* maintained its healthy condition during a spell of drought. A small area of Nandi coffee (*Coffea eugenicides*) was planted out during the short rains. A small coffee factory, especially designed to deal with the experimental work in progress, was erected during the year.

Research work on coffee mealy-bug has been pursued with vigour, and with the information now available in regard to control measures planters are placed in a position to prevent large-scale losses, provided that steps are taken in due time. Unfortunately, however, the cost is appreciable, and financial difficulties may hinder essential measures being carried out in advance of the onset of the pest. Statements made in regard to losses caused by mealy-bug have not infrequently been much exaggerated. The view is held that some of the loss is to be ascribed to adverse climatic conditions which synchronised

with the prevalence of the pest in the districts so infested. Reports show that mealy-bug is more widely distributed in the Limuru and Makuyu districts than in previous years. A series of manurial trials in connexion with mealy bug infestation have been laid down as a result of investigations carried out by the Assistant Agricultural Chemist and the Senior Coffee Officer.

Arrangements were made with the manufacturers and their agents to undertake the manufacture and supply of Kresotow, as it was considered that the obligation need no longer rest upon this Department.

The Solai and Subukia Associations requested that their districts might be declared "closed areas" with regard to the importation of coffee plants and seeds, with a view to maintaining freedom from pests and diseases. Two other District Associations have asked for the prohibition of the movement of plants of all descriptions into their districts, with the same end in view. Action has been taken thereon.

Frequent inspections have been made in the Ithanga area with a view to preventing the spread of the already serious outbreak of the white stem borer (*Anthores*) in that area. Infestations by the black and yellow-headed borers are also on the increase, more particularly in the Kikuyu Province.

Asterolecanium is becoming more widely distributed in the Thika-Makuyu area, and has been reported for the first time on the slopes of Elgon.

In Nyanza Province, *Antestia* has caused considerable loss of crop, but the response of planters to a notification that spraying was compulsory against leaf-eating caterpillars has been most satisfactory, and it is hoped that they will continue to make vigorous efforts to stamp out this pest.

Coffee Berry Disease is reported by inspectors to be on the increase in Sotik, Kericho, Kaimosi, Turbo, and parts of the Trans Nzoia. A deputation of planters from Sotik and Kericho waited on the writer in November to discuss the matter, as a result of which the Mycologist and the Senior Coffee Officer visited the area to inquire into the incidence of the disease generally and the allegations made as to the inefficacy of the sprays used against it. They are of the opinion that the losses from the disease have been somewhat exaggerated, but nevertheless the situation is one demanding close attention. More attention should be given to the pruning of

the trees to increase their vitality, and to the improvement and maintenance of soil fertility. Steps have been taken to pursue soil investigations, and manurial trial plots will be laid down in the area early in 1930.

The Senior Coffee Officer attended or held fourteen meetings of those interested in the coffee industry in various parts of the country, when matters such as special coffee services, proposed research institute, kresotow, coffee berry disease, application of the Diseases of Plants Prevention (Coffee) Rules, etc., were discussed.

TEA.

The area under tea as at 31st July was 5,593 acres, as compared with 4,809 acres in the previous year.

It is recorded that 152,813 lb. "prepared" tea were produced during the year; of this quantity, 7,906 lb., valued at £738, were exported. The industry is being promoted chiefly by companies possessing experience and the necessary financial backing. Plans of development are being carried out for extensions of tea gardens and factories during the next few years. Already five well-equipped factories have been erected. There is promise that both in yield and quality success will be attained.

SISAL.

A large increase in the area planted with sisal is again recorded.

The total area as at 31st July is returned at 109,375 acres, an increase of 17,366 acres over the previous year. The area ready for cutting, i.e. over three years old, is given at 54,197 acres.

Exports of sisal fibre and tow increased from 290,190 cwt. in 1927-28 to 349,174 cwt. in 1928-29. The value of these exports amounted to £420,777 and £583,164 respectively. From returns received, the estimated production for the census year ending 31st July, 1930, is 417,340 cwt., as compared with an actual production for the previous year of 316,180 cwt.

Sisal-growing may not be regarded as an ordinary farming pursuit. Given suitable soil and climatic conditions, success depends more upon factory management, labour organisation, and economics than upon usual farming practice. The demands made for Departmental services have been small, but such as have been required have been rendered. The Agricultural

Chemist brought to fruition an important investigation into the production of industrial alcohol from sisal waste, and the Mycologist has tested out apparent damage to sisal with negative results in relation to disease. Though at present a "key" industry, it is advisable that the requirements of the sisal industry should be studied along fundamental lines. On the side of economics, an investigation is needed in regard to cost of production to determine the most economical methods and practice in connexion with large scale operations. Again, the plant itself, as far as can be ascertained, has never been studied on the physiological side in relation to fibre production, the best and most profitable stage of growth when the leaves should be decorticated, and the quality and yield of fibre. These questions require the combination of a physiologist and plant breeder working in harmony, and it has been suggested that the work should be centred at Amani. On the engineering side, the value of invention is shown in the introduction of a new process of "dry" decortication, mentioned in my last report. In other directions, improvements may be effected in sisal machinery. Again, with an increase in output of sisal fibre and a reduction in prices, the need to find new uses for the fibre will almost surely arise. That will be the business of the inventive manufacturers. These matters are mentioned to show that it is not advisable that the industry should stand still, and it is gratifying to note that the Sisal Growers' Association in this Colony is fully alive to their importance and has collaborated with this Department in proposals for dealing with them. Agreement has been reached whereby the industry is prepared to contribute towards the cost of special Sisal Services by means of a levy on sisal exports, to which it is proposed that Government should contribute on a £ for £ basis.

SUGAR CANE AND SUGAR.

A further increase of 1,753 acres is recorded in the area of sugar cane on European holdings. There is now a total of 11,161 acres on these holdings, and 8,820 acres on farms occupied by Indians, making a total of 19,981 acres, as compared with 13,096 acres in the preceding year. The increase on Indian holdings, amounting to 5,127 acres, is noteworthy.

Owing to the unfavourable season, the output of crystallised sugar fell from 127,034 cwt. in the year 1927-28 to 123,040 cwt. in 1928-29, and exports dropped from £38,696 to £31,165 during that period.

Importations of sugar decreased considerably during 1929 as compared with 1928, but were still greatly in excess of the three previous years. The following shows the quantities and values of importations over the past five years :—

YEAR			QUANTITY	VALUE
			<i>Cwt.</i>	£
1929	..	..	48,029	38,576
1928	..	..	80,244	68,903
1927	..	..	9,623	10,661
1926	..	..	19,567	20,265
1925	..	..	27,161	31,475

Progress has been made by the establishment of two new mills, one at the Coast and the other in the Highlands. The industry was started some years ago, and, notwithstanding heavy protection afforded through Customs duty and preferential railway freights in favour of locally-produced sugar, it is somewhat disappointing that a larger proportion of the imports has not been displaced. This position may be taken as an illustration of the difficulties in establishing an industry new to a country, and one in which a large amount of capital expenditure is involved. It is important that every care should be exercised in the selection of estates for sugar production. Not only must the rainfall be adequate, or a sufficiency of water be available for irrigation, but it is essential that the land should possess high fertility in order that heavy crops of cane may be grown. As some of the areas suitable for growing sugar cane are far distant from the Port, and therefore may not be able to compete on the world's markets against countries more favourably situated, it is felt that the local market, particularly that of a large potential trade among the native population, should be fostered, but that will not be done successfully unless the sugar is sold at a much lower price than at present.

It is expected that the measures taken by the Department for the purpose of eradicating " mosaic " disease in the Nyanza Province—the only area in which it is known to exist—will succeed, and that the restrictions in regard to the growth of any variety of cane other than Uba will be removed next year. In order to protect the Colony from the introduction of " mosaic " disease, imported canes are grown in quarantine under supervision. Improved varieties of cane have been introduced by the Department, and as the " plant cane " from them becomes available it is distributed among planters.

COCONUTS.

A slight increase in the area of European-owned coconuts occurred during the year. This area is now given at 8,568 acres, as compared with 7,994 acres in 1927-28.

Increasing quantities of copra are being used locally in the manufacture of soap. This, combined with lower market prices overseas, had the effect of reducing exports very considerably.

During the period 1927-28 (August-July) only 5,270 cwt. of copra were exported, as compared with 27,860 cwt. in the previous year.

The yield of coconuts and copra is very low in several plantations, due chiefly to unfavourable soil conditions. Non-Europeans are little interested in extending copra production on a commercial basis, and appear satisfied with a sufficiency for their own needs in respect of food and drink.

Inspection was carried out and instructions issued in regard to the removal and destruction of palms affected by "bud rot."

WATTLE.

An extension of the wattle industry is revealed in the export figures of bark and extract, as shown in the following statement :—

WATTLE BARK

1929		1928		1927		1926		1925	
Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Cwt.	£	Cwt.	£	Cwt.	£	Cwt.	£	Cwt.	£
63,342	25,336	101,619	39,112	44,082	17,338	36,537	13,702	89,964	28,991

WATTLE EXTRACT

27,777	28,310	20,284	22,478	21,229	19,188	12,396	11,156	9,203	2,966
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A second factory for the manufacture of wattle extract is in process of erection.

Extensive areas of the Kikuyu Province, particularly in the higher altitudes of the Native Reserves, are admirably suited to wattle-growing, and during the last year in particular the supply of bark has come chiefly from native sources. The wattle tree (*Acacia decurrens* and *Acacia mollissima*) serves

several useful purposes to natives. It provides shelter around the huts, it provides poles for house-building, it supplies fuel, and, from the sale of the bark, cash is obtained. As is not unusual in the early stages of an industry, bark of low and mixed quality has been shipped, bringing discredit upon the reputation of the output. Instruction has been given in regard to the care which should be exercised, and the preparation of bark for market. A survey has been made of the wattle areas, and it is seen that steps will require to be taken to prevent species of *Acacia* other than those with high tannin content from being grown for the sale of bark either to the factory or for export.

POTATOES.

There has been a very considerable increase in the export trade in potatoes, as is shown by the following table :—

YEAR	1925	1926	1927	1928	1929
	<i>Cwt.</i>	<i>Cwt.</i>	<i>Cwt.</i>	<i>Cwt.</i>	<i>Cwt.</i>
Quantity Exported ..	33,803	44,019	43,105	57,296	82,755
	£	£	£	£	£
Value	7,726	10,999	10,036	16,990	27,050

Of the 1929 exports, over 80 per cent was shipped to Bombay, where a market for Kenya produce is becoming established, and where the value of the Kenya grading certificate is fully appreciated.

At the present time, the supplies are derived mainly from native sources, but it should be profitable also to European growers, who might develop a trade for named varieties used largely for seed purposes. There can be little doubt but that the adoption of the official grading system has saved the trade and has been the means whereby it has been developed along safe lines. The Department has also promoted the industry by the importation of the best varieties and the distribution of seed grown therefrom.

MISCELLANEOUS CROPS.

A large range of crops was referred to in the census returns under the head "Miscellaneous Crops." It covers oats, wattle, buckwheat, cabbage, carrot, cassava, chillies, essential oils, ginger, groundnuts, kale, lucerne, lupin, mangel, melon, millet, onion, potato, pumpkin, rape, rice,

rye, simsim, sweet potato, teff grass, tobacco, turnips, etc., and also areas under nurseries. The area under these covers 28,543 acres, as compared with 24,384 acres in the previous year.

Several of these crops are likely to be more extensively planted in the near future, particularly those which can be used for fodder purposes. Rotation and green manuring crops are also likely to be much more extensively planted.

LIVE STOCK.

Native live stock are dealt with in certain respects under the title, "Native Agriculture"; also in the Report of the Chief Veterinary Officer.

Cattle.

The total number of cattle in the possession of Europeans on the 31st July was 218,390, an increase of 1,419 over the previous year.

The following table shows the numbers of live stock owned by Europeans during the last five years:—

	1925	1926	1927	1928	1929
Cattle—Total	216,589	213,423	215,650	216,961	218,390
(a) Breeding Stock ..	110,547	105,556	107,434	110,796	115,777
(b) Oxen	106,042	107,867	108,213	106,165	102,613
Horses	1,846	1,844	2,137	2,172	2,288
Mules	922	780	719	709	632
Donkeys	1,336	931	1,046	1,238	1,235
Sheep (Wool-bearing) ..	140,725	162,848	172,299	176,261	210,912
Sheep (Native)	38,071	43,057	32,972	20,603	24,568
Goats	5,372	4,454	3,697	3,211	3,926
Pigs—					
(a) Breeding Sows ..	2,040	1,714	2,896	3,455	3,108
(b) All others	6,524	7,411	10,061	14,697	14,638
Poultry	31,150	35,728	43,988	38,845	35,786

The above returns show a small increase in the number of breeding stock. The decrease in the number of oxen is accounted for through their displacement by mechanical power. The previous drop in breeding stock has been arrested, been arrested, and there is evidence that interest is again being awakened in cattle-breeding and the improvement of herds.

This Colony participated in the scheme inaugurated by the Empire Marketing Board and shared equally with that Board the cost of shipping freight on pure-bred stock imported from Great Britain. On this service the contribution from this Government amounted to £1,295 in 1929, which included arrears of payment in respect of some animals imported in 1928.

Grants-in-aid were paid in respect of the importations of 17 bulls, 22 cows and heifers, 4 pigs, and 22 sheep during the year.

Particulars of pure-bred cattle imported during the last four years are as follows :—

	1926	1927	1928	1929
Shorthorn Cows and Heifers ..	..	..	..	10
Shorthorn Bulls	26	18	20	16
Friesland Bulls	4	77	13	27
Friesland Cows and Heifers ..	..	..	6	26
Ayrshire Bulls	9	10	17	16
Ayrshire Cows and Heifers ..	1	3	8	7
Aberdeen Angus Bulls	1	..	1	2
Jersey Bulls	2	..	..	2
Jersey Cows and Heifers ..	6	..	..	..
Polled Hereford Bulls	..	1	..	..
Black Welsh Bulls	..	4	3	..
Black Polled Angus Bulls ..	..	4	..	..
Guernsey Bulls	..	1	..	..
Blue Albion Bulls	..	..	2	..
Welsh Bulls	..	12	4	..
Red Pol'l Bulls	3	..	8	6
Red Poll Cows and Heifers ..	..	..	..	2
Galloway Bulls	..	..	..	1
Galloway Cows and Heifers ..	..	..	..	3
Afriander Bulls	..	..	..	1
TOTALS	56	130	82	119
Total Bulls	45	127	68	71
Total Cows and Heifers ..	11	3	14	48

In some respects it is to be regretted that so many breeds are being imported, and in the absence of supporting herds in this Colony breeders will find it difficult and expensive to maintain their purity and quality.

A welcome change is seen in the increase in the number of cows and heifers imported. The view is again expressed that breeders in possession of other than pure-bred and high-grade herds should not be expected, on financial grounds, to use bulls costing £100 and over, as in the case of imported bulls, and that pure-bred bulls of a quality good enough for their purpose should be bred in the Colony and be available at a lower cost than the imported animal.

It is clear that the best opportunity for European stock-owners lies in the breeding of dairy cattle and the pursuit of a dairying industry. For natives the best market in the future, apart from the comparatively small number required to supply butchers' shops in townships, lies in supplying an increasing demand for consumption in native areas, a demand which should be encouraged in every way in order that the native diet may be improved. Other surplus nondescript native cattle which represent the largest proportion should be used up through meat factories for the manufacture of beef extract, fertilisers and other bye-products, but it remains to be seen to what extent natives may respond to persuasion, or may be required by compulsion in their own interests, to dispose of such stock whose economic value is so low.

The establishment of a meat factory for dealing with surplus native stock, particularly those of indifferent quality, has received attention, and much information in connexion with the project has been collected. In order to place the native live stock industry on an economic basis it is necessary to reduce over-stocking, and to arrest the destruction which is being caused in native reserves mainly pastoral in character. It may, however, be said that those who have had little experience of semi-arid conditions do not realise fully the recuperative power of such areas when there is a return to good or normal rainfall conditions.

In the light of experience, it is considered that activities in native reserves should be directed towards securing a greater output of animal produce, also in improving the preparation of hides for market, and animal husbandry generally, so that greater benefits may be derived from the expenditure hitherto incurred upon disease control.

Reference was made in my last report to the value and importance of legislation dealing with the Fencing of Farm Holdings and Cattle Cleansing (Dipping). The Bills dealing therewith have undergone close examination by a Select Committee of Legislative Council, after consultation with stock-owners, and they passed their third reading at the end of the year under review.

The Committee of Civil Research accepted the offer of this Government to place the Government Farm, Naivasha, together with a grant of £5,000 at the disposal of the Rowett Institute, Aberdeen, in order that a new series of experiments might be carried out in the application of results previously obtained to stock farming practice. The experiments will mainly cover: (1) The addition of concentrated and mineral foods to pasture; (2) the effect of the application of fertilisers upon the chemical and botanical composition of pastures. The farm, in so far as is possible, will be run on commercial lines, and it is hoped that it will prove, in addition, a useful demonstration of the value of sound management. The work is being done in close collaboration with this Department.

Sheep.

The following table gives particulars of importations of sheep during the last four years:—

YEAR	Rams	Ewes
1926 ..	168	17—(176 Merino and 9 Kent or Romney Marsh).
1927 ..	87	10—(89 Merino and 8 Kent or Romney Marsh).
1928 ..	245	100—(202 Merino,*110 Black Head Persian,*4 Suffolk Down, 20 Dorset Horn, 3 Cheviot and 6 Kent or Romney Marsh)
1929 ..	58	34—(63 Merino, 6 Romney Marsh, 2 Dorset, 6 Karakul, 15 Miscellaneous).

* Imported by Government.

The set-back which was apparent in the sheep industry during 1928 has been arrested. The number of "woolled" sheep is now 210,912, as compared with 176,261 in the previous year, an increase of 34,561.

Native sheep on European-owned farms also increased from 20,608 in 1928 to 24,568 in 1929.

The export of wool increased from 7,899 cwt. in 1928 to 9,136 cwt. in 1929, but as the result of a fall in market prices the export value decreased from £103,040 in 1928 to £98,871 in 1929.

The building up of a wool industry, based upon Merinos, is being steadily pursued. The decreased demand and lower prices for wool have adversely affected clips like those of Kenya, whose " marks " are not so well established and whose quality is not so high as those from countries where high quality Merinos have been bred for long periods of time. A larger supply of good " flock " ewes must be available before the industry can become firmly established on a reasonable scale. The need for a technically-trained officer, experienced in sheep management, the mating and classing of ewes, and the preparation of wool for market, is again emphasised, particularly at this stage of development of the industry.

Pig Industry.

During the year the pig industry has received considerable attention from the Department, chiefly with a view to improving the quality of bacon produced. At the end of April the first pig industry conference was held, at which were discussed the cost of production, the question of supply and demand, export trade for pig products, co-operation, the improvement of pig-breeding and feeding methods. It was further decided to constitute a pig industry consultative committee to inquire into all matters relative to the industry, including the opening up of new markets to absorb surplus production, as the present pig population of the Colony is sufficient to supply more than the local market.

The following statement shows the number of pigs in the possession of Europeans during the past five years :—

	1925	1926	1927	1928	1929
Breeding Sows	2,040	1,714	2,896	3,455	3,108
All others	6,524	7,411	10,061	14,697	14,638
TOTAL ..	8,564	9,125	12,957	18,152	17,746

It will be observed that the total number has rather more than doubled itself during the quinquennial period. A slight falling off, however, is apparent in comparing the 1929 figures

with those of 1928. The decrease is almost wholly in respect of breeding sows, and may be attributed to the present saturation of the market, to which reference has already been made.

HIDES AND SKINS.

Much attention has been given to the hides and skins trade, and the Department is indebted to the sub-committee of the Mombasa Chamber of Commerce, with whom several discussions have been held, for their constant co-operation and assistance. It is considered that any hard and fast system of grading would be impracticable of administration, and other means of improving the quality of hides and skins are being diligently investigated.

Veterinary and Agricultural Officers have been carrying out propaganda and demonstration work in native reserves, and in the Nyanza Province a number of *bandas* for the shade-drying of hides have been erected.

No radical improvement, however, can be effected until a return, commensurate with the additional labour involved, is obtained. At present little differentiation is made between well-prepared hides and others.

For the improvement of the industry, it is considered that at this stage the following measures should be adopted :—

1. The continuation of educational work and propaganda.
2. The provision of shade drying facilities at chief centres of production.
3. The establishment of market centres, and the display thereat of current market prices for hides and skins of different qualities.
4. The prohibition of sale or offer for sale of hides possessing certain pronounced defects in "trimming"; likewise, at places within a certain radius of such market centres where shade drying facilities are provided, of hides other than shade dried.
5. That it shall be made a punishable offence to offer for sale "plastered" hides and hides treated in any way to conceal defects.

ANIMAL PRODUCTS.

The following is a comparative table of the animal products sold by Europeans during the last five years :—

YEAR	Milk (Whole)	Cream	Butter	Cheese	Ghee	Bacon and Hams	Wool
	<i>Gal.</i>	<i>Gal.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>
1928-29	791,452	212,914	290,905	145,609	65,215	603,233	938,619
1927-28	421,779	75,764	324,593	130,533	78,528	519,463	420,575
1926-27	617,747	92,640	216,863	143,305	124,057	No re- turn	632,088
1925-26	395,031	72,693	291,894	144,070	115,815	430,119	670,752
1924-25	371,692	85,557	303,085	92,994	108,153	364,552	461,586

The fluctuations in the proportions of the different kinds of dairy products sold as milk-manufactured products are to be noted.

Taking the ratio of—

2.25 gallons of milk to 1 lb. butter,

1.1 gallons milk to 1 lb. cheese,

2.6 gallons milk to 1 lb. ghee,

it is calculated that the primary producer—milk—has increased from 2,069,843 gallons in 1927-28 to 3,904,856 gallons in 1928-29; an increase of 1,836,013 gallons, or 88.7 per cent.

Statistics were called for showing the quantities of milk and cream received by the local creameries during the year ended 31st July, 1929, and the products manufactured therefrom.

The following are the total figures of the quantities received and manufactured :—

Quantity of milk received from farmers	Quantity of cream received from farmers	Quantity of butter produced	Quantity of cheese produced	Quantity of ghee produced
<i>Gal.</i> 46,899	<i>Gal.</i> 219,593	<i>lb.</i> 574,041	<i>lb.</i> 32,243	<i>lb.</i> 23,714

The better organisation of the dairy industry through the establishment of Co-operative Creameries has undoubtedly stimulated production. The increase for the year ended July 31st, 1929, is remarkable, and it is believed that it is still

greater for the calendar year. The improvement in grazing due to better rainfall has greatly increased the yield of milk and it is seen that a considerable surplus of butter will be available for export. Its quality has been proved to be acceptable in the European market, but more experience and greater care is needed in the manufacture of cheese as much of that now produced will only find a market with difficulty. There has been a consistently steady increase in the production of bacon and hams; the outstanding increase in wool is partly to be accounted for by an overlap in the clips of the two preceding years.

The Department was strengthened at the beginning of the year by the services of a Live Stock Officer, who has been mainly engaged upon promoting the dairy and pig industries. Farm visits totalling 223 were paid by him with a view to obtaining first-hand knowledge of the conditions prevailing in the Colony, and at the same time giving advice on the breeding and management of stock, and the trial and use of fodder crops. In connexion with dairying, encouragement of co-operation, advice on the proper care of milk and cream on the farm, and practical help in cheese-making has been given. Pig breeding, management and feeding, has received special attention with a view to the raising of pigs of the best quality for bacon purposes along the most economical lines. In addition the Live Stock Officer addressed 297 letters, chiefly to enquirers seeking advice.

“ EAST AFRICAN STUD BOOK.”

Several meetings of the Stud Book Committee have been held, and applications for entry to the next volume have been certified by this Department, as required. No new volume was published during the year.

A sum of about £125 stood to the credit of the Stud Book account, on the books of the Royal Agricultural and Horticultural Society, as at December 31st.

It is gratifying to note that an increased number of pure-bred females, cows, heifers and ewes, have been imported during the year, which will naturally increase the scope of the Stud Book by laying the foundation for locally bred pedigree stock.

INDIAN AGRICULTURE.

The activities of Indian occupiers of land are confined to (a) a few individual holdings at the Coast which do not contribute substantially to production, though a quantity of

coconuts, copra and fruit is marketed from them; (b) a number of market gardeners engaged chiefly in supplying the Nairobi market with vegetables; and (c) an Indian farming community settled in the Kibos-Miwani area. Considerable development is taking place in this area, chiefly for the growing of sugar cane.

Through the Nyanza Indian Farmers' Association, information has been furnished in respect to the operations of this community. The following are comparative figures of the development in this area over the past two years :—

	1928	1929
Total number of occupiers	40	48
Area occupied	4,217 acres	13,200 acres
Area under Sugar Cane	3,693 "	8,820 "
Area under Maize	55 "	200 "
Area cultivated but not planted ..	437 "	980 "
Number of working oxen	1,234	2,015
Number of other cattle	746	600

In the last Agricultural Census year 39,900 tons of sugar cane were cut and found its market chiefly at the sugar mill in the same district, as compared with 28,800 tons in the preceding year.

COAST AGRICULTURE.

Reference is made in appropriate sections to coastal conditions and activities. It is hoped that Agricultural Services in this area will shortly be strengthened by the establishment of an Experiment Station, and in other directions. There are indications that greater interest is being awakened in agricultural development in the coastal belt by non-native enterprise, and there is evidence of advancement and greater production among native tribes. Steps have been taken to give effect to the recommendation of the Agricultural Commission in connection with the appointment of an Advisory Committee on Agriculture at the Coast.

NATIVE AGRICULTURE.

The following report on this section has been prepared by the Deputy Director (Mr. E. Harrison).

" The number of officers engaged on the work of this section at the beginning of the year was seven, while three officers were on leave. The former were stationed as follows :—

Nyanza Province.—Mr. A. G. Bailey, Bukura School and Central Kavirondo; Mr. R. G. Bentall, Bukura School and cotton areas.

Kikuyu Province.—Mr. W. L. Watt and Mr. S. Gillett, Scott Agricultural Laboratories and South Kikuyu Reserve; Mr. A. S. Hartley, Embu; South Nyeri and Fort Hall; Mr. W. O. Sunman, Meru.

Coast Province.—Mr. C. O. Oates, Digo to Malindi.

Mr. W. G. Leckie, Mr. H. J. Taylor and Mr. C. G. Bishop were on leave.

The following changes took place during the year :—

Mr. Watt, Agricultural Officer, proceeded on leave in January, and Mr. Gillett, Assistant Agricultural Officer, was left in charge at Scott Agricultural Laboratories.

Mr. Finch, Assistant Agricultural Officer, was appointed locally in April and was posted to Fort Hall.

Mr. Bolton, Temporary Assistant Agricultural Officer, was posted to Bukura from April to August.

Mr. Taylor, Assistant Agricultural Officer, returned from leave in April and was transferred to advisory work in European areas, and posted to Nakuru.

Mr. Bishop, Assistant Agricultural Officer, returned from leave in May and was reposted to South Kavirondo.

Mr. Leckie, Agricultural Officer, returned from leave in May and took charge at the Scott Agricultural Laboratories and South Kikuyu Reserve.

Mr. Cottingham, Temporary Assistant Agricultural Officer, was posted to Bukura School in September.

Mr. Watt, Agricultural Officer, returned from leave in August and was stationed in Nairobi.

Mr. Bentall, Assistant Agricultural Officer, proceeded on leave in September and was replaced by Mr. Ransford, Assistant Agricultural Officer, who arrived on first appointment in October.

Mr. Watt took over Bukura School from Mr. Bailey, Agricultural Officer, who proceeded on leave in December.

Mr. Gaddum, Assistant Agricultural Officer, arrived on first appointment in December and was posted to the Scott Agricultural Laboratories.

At the end of the year there were eleven officers (one temporary) on active work, and two on leave.

To supplement the work of these officers, sixty-eight native agricultural instructors were employed, and were distributed as follows :—

Nyanza Province—14 : North and Central Kavirondo, 12 ; South Kavirondo, 2.

Kikuyu Province—35 : South Kikuyu, 10 ; Fort Hall, 5 ; Embu, 9 ; South Nyeri, 5 ; Meru, 6.

Coast Province—17 : Kwale, 1 ; Mombasa, 7 ; Kilifi, 7 ; Malindi, 2.

Ukamba Province—2 : Voi, 1 ; Machakos, 1.

The shortage of good housing in reserves for officers operating in the above areas is still most marked. It is hoped that in the near future the imperative necessity of providing proper and fit housing accommodation for district staff will be met.

In addition to the two schools of instruction, viz. Bukura and Scott Laboratories, provision has now been made for an experimental and training farm at the Coast, thus meeting a need which has been pressed since 1924. A school is needed either at Embu or near Nyeri to replace the school at Scott Laboratories which it is intended to develop as a place for higher training of selected pupils from the other schools.

The Department maintains a large number of demonstration plots, some of which are as large as ten acres, thus adding to the quantity of improved seed for issue, and saving money on the seeds vote. The peripatetic Ploughing School mentioned in the last report has been at work as two units, one in Embu and one in Fort Hall. It is proving of interest to native people and is of value where large seed plots are established. It is hoped to provide more units during the year 1930.

The issue of seed to native areas has been maintained and increased somewhat, particularly through votes from Local Native Councils. In 1928, a total of 21,780 lb. of seed was provided by these bodies ; in 1929, 126,980 lb. was so secured. In addition to these normal issues, the incidence of drought and famine was taken advantage of and large quantities of " famine " seed were issued in Embu, Meru and on the Coast. The coastal people provided the funds for the

issues made to them and the Embu and Meru are expected to pay during the next few years. A total of 667,631 lb. was so issued, the major portion of which it is known was planted.

In addition to paying for seed and poultry, Local Native Councils are more inclined nowadays to pay for instructors, particularly in Kavirondo, where some eight ploughing instructors are employed.

In regard to poultry, it is evident that the demand for better birds is increasing rapidly. Consideration has been given to the problem of supply and it is proposed to establish one station at least from whence natives may secure sittings of eggs. Briefly, the proposal is to maintain some twenty breeding pens of Rhode Island Red birds if possible unrelated, and to number the eggs from each pen differently. A native is to be issued five eggs bearing different numbers so that the chickens therefrom will be unrelated. The native does not usually eat eggs, so that it is more than likely that a rapid improvement in reserve poultry up to a high standard may be achieved, without the risk of some of the effort being frustrated by the consumption of the issue. It is proposed at first to establish one plant in a reserve where conditions are good and foodstuffs plentiful and cheap. There is a growing demand, particularly on the Coast, for pens of breeding birds.

The improvement of sheep and cattle and also poultry in some areas, is being pursued, and more attention is being devoted to this matter now that inoculations are welcomed by native stockowners.

Instruction has been given where possible on the shade drying of hides, but the progress recorded is but slight, possibly due to apathy induced by low prices. A native invariably expects a high reward quite incommensurate with the effort he makes, and advance in quality of material and in its better manipulation must await compulsion or rather a more reasonable attitude on his part. Every opportunity of explaining rises and falls in prices should be taken advantage of; numberless instances occur naturally in reserves and these should be pointed out and enlarged upon.

The annual increase in the area under cultivation is most pleasing and the growing popularity of labour-saving appliances is noteworthy. In the Meru Reserve, iron hand implements are displacing the wooden ones formerly largely used, to some extent as a result of the growing numbers of Meru people who go out to work in settled areas, returning each with an implement of some kind.

Plantation industries in native areas are possible developments, as the fear of losing his land fades from the native mind. It is hoped that the work of establishing numerous Black Wattle plantations in the South Kikuyu and Fort Hall Réserves will be found valuable and effective. In this and efforts cognate to it, co-operation with factory owners will be needed, and in the mutual co-operation of the technical factory owner and the native producer in the future, there offers a wide field, and one worthy of examination from time to time. The fewness or comparative absence of forestry officers from native areas has in several districts made it necessary for Administrative and Agricultural Officers to establish nurseries for the propagation of tree transplants.

Efforts should continue to be made to induce natives to apply animal manure, particularly on vegetable gardens; the culture of vegetables is increasing and attention is directed towards this side of the officers' work.

It will have been observed that up to the present the chief concern of officers of the Department has been to encourage the growing of food crops, in the belief that a bountiful supply of food is essential to the peaceful development of the people and that once assured, other and more valuable crops may in turn be produced in increasing quantities.

The live stock problem was reviewed in a paper written for the Pan-African Agricultural Conference held in 1929. The possibilities of co-operation between the creamery and the native cattle owners were discussed with the Directorate of the Lumbwa Creamery in 1924, when on account of the nature of communications, the establishment of a chain of separating stations in the Lumbwa Reserve was considered to be non-practicable. The sale of milk by natives and its separation is increasing rapidly and as rail communication is being provided in two reserves, the proper establishment of separating stations and their control should be brought under review. In the Kisii district four Local Native Council dairies produced a total of 8,822 lb. ghee, and 3,608 lb. butter, while the export from Asembo in Central Kavirondo has been as high as 18,000 lb. of ghee in a single month.

Meetings of Officers.—In the past, meetings of officers were arranged at important Native Agricultural Shows, but a meeting of the staff operating in native areas was held in Nairobi in 1929 prior to the sitting of the Agricultural Commission. At these meetings there is a valuable interchange

of views and a discussion of measures to be adopted in the future. Furthermore, contact is established with scientific workers at the laboratories; from which may arise co-operative work of mutual benefit.

The points discussed on which resolutions were passed were as follows :—

Crops.

- (i) Weeds.
- (ii) Coast Experimental Farms.
- (iii) Demonstration and seed-raising plots; labour, etc.
- (iv) Development of agriculture, leaflets simple and forceful, the educational value of the market place, Wattle development, migration of people.
- (v) Introduction of new crops and need for Economic Botanist.

Stock.

- (vi) Hides and skins; Legislation *re* Bandas and Banda Staff.
- (vii) Overstocking, movements, taxation, " Lobola ". Death duties. Crown lands—importance of separate live stock and agricultural staff. Improvement—customs of people; production of cream and ghee; slaughter; defer introduction of exotic blood.
- (viii) Poultry issues.

Marketing.

- (ix) Market licences and native co-operation.
- (x) Central factories; Cassava, Cane, Wattle Extract.

General.

- (xi) Winnowing machines for simsim.
- (xii) Scales at trading centres.
- (xiii) Irrigation—introduction of Wachegga instructors.
- (xiv) Soil analyses.
- (xv) Imprisonment of cultivators.

- (xv) Importance of Provincial meetings and Provincial organisations.
- (xvii) Joint *safaris*.
- (xviii) Taking over districts, posting of young officers.
- (xix) Status of staff.
- (xx) Probationers—native apprentices.

It was arranged at the conclusion of the three day meeting that it would be wise to hold meetings twice a year, in Nairobi, and that staff should receive instruction at the Laboratories.

THE SCHOOLS.

During the year the permanent buildings for housing native pupils, together with a large dining room and kitchens, were erected at the Scott Laboratories. Developments at this centre in connection with other departmental activities require that additional land be sought.

In view of the fact that the boma at Kakamega is now a fixed site, consideration has been given to the removal of departmental activities from Bukura (at which point it was once expected that the boma for North Kavirondo would be established) to the lands of Kakamega. The matter is under review and a decision should be arrived at early.

PUPILS AT BUKURA AND SCOTT AGRICULTURAL LABORATORIES—NUMBERS IN TRAINING AND EMPLOYED.

	Number of Pupils at		Number sent out trained	
	cott abs.	Bukura	Scott Labs.	Bukura
1923.. ..	21	..	..	..
1924.. ..	42	30	..	..
1925.. ..	43	32	10	..
1926.. ..	34	55	28	..
1927.. ..	42	45	..	9
1928.. ..	50	36	8	4
1929.. ..	48	32	24	20

No pupils completed the course at the Scott Agricultural Laboratories in 1927 owing to lengthening of course from two to three years. Of those passed out :—

Scott Agricultural Laboratories.

1925—10 ...	8 as Instructors.
1926—28 ...	14 as Instructors.
	3 as Mission Teachers.
	4 Trading.
	7 Other occupations.
1928— 8 ...	4 Plant Breeding Assistants.
	3 Instructors.
	1 Native Chief.
1929—24 ...	14 Instructors.
	2 Forestry Department.
	1 Teacher.
	1 Alliance High School.
	6 Returned to Reserve.

Bukura.

1927	9 Engaged as Instructors by Local Native Council.
1928— 4 ...	2 as Teachers.
	2 as Clerks.
1929—20 ...	7 Instructors.
	8 Instructors engaged by Local Native Council.
	5 working at homes.

WEATHER CONDITIONS.

Nyanza.—The weather for the most part was favourable, the rainfall being rather above the average. In a few districts of Central Kavirondo the fall was erratic, with a dry spell in the middle of the growing season. A little hail fell in April.

Kikuyu.—The long rains were rather late but were adequate everywhere except in Meru, where they were very poor. The short rains were above the average, and exceptionally heavy in the northern half of the Province.

Coast.—After the poor rains of 1928, the long rains this year were good, although anxiety was caused by a three weeks' gap in the middle of the growing season. The short rains were very good.

Speaking generally, the early part of 1929 was dry and crops failed in various places, notably Embu and Meru, and Machakos and the Coast. Locusts too were troublesome. There was a shortage of food until the Kavirondo maize crop came on the market, when the whole of that surplus was absorbed locally. The Fort Hall and Embu people, towards the end of the year, were feeding the people of Kitui and some Meru and Machakos people. The value of surplus native production of foodstuffs has been most marked this year.

SEEDS SUPPLIED FROM DEPARTMENTAL VOTES.

	Kikuyu	Nyanza	Kerio	Ukamba	Coast	N.F.P.	Total
	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>
Maize	52,000	46,000	28,650	4,600	24,000	5,800	161,050
Wheat	22,600	2,000	60	1,200	231	565	26,656
Matama	..	1,800	9,180	..	..	80	11,040
Mwele	..	1,440	..	..	..	..	1,440
Barley	..	..	..	..	..	360	360
Buckwheat ..	..	..	..	..	..	14	14
Rice-Sena ..	60	..	..	..	..	..	60
Beans	..	9,000	..	4,000	..	200	13,200
Peas	1,000	480	..	..	..	..	1,480
Chiroko	..	1,030	540	..	..	..	1,620
Mbaazi	..	1,080	720	170	..	15	1,985
Cowpeas	..	..	..	600	..	7	607
Lucerne	..	25	60	..	..	..	85
Groundnuts ..	420	7,200	..	..	..	175	7,795
Simsim	361	..	..	..	3,646	65	4,072
Potatoes	3,400	..	..	..	..	..	3,600
Tobacco	..	..	2	..	..	2	4
Vegetable Seed	20	4	9	28	..	..	61

TOTAL .. Lb. 235,129

ISSUES OF SEEDS AND POULTRY FROM SCOTT AGRICULTURAL LABORATORIES.

	<i>lb.</i>
Maize	1,000
Wheat	2,100
Beans	1,500
Peas	1,200
Lucerne	20
Potatoes	1,800
Rhode Island Reds (196)—	
Cockerels	81
Pullets	115

SEEDS SUPPLIED FROM LOCAL NATIVE COUNCIL VOTES.

	Kikuyu	Nyanza	Kerio	Ukamba	Coast	Total
	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>
Maize	13,200	..	..	3,000	58,000	74,200
Wheat	7,000	3,000	..	1,200	..	11,200
Maweale	3,900	..	..	..	..	3,900
Wimbi	..	..	9,000	..	..	9,000
Beans	9,300	..	6,000	3,000	..	18,300
Peas	120	..	..	..	..	120
Chiroko	..	6,000	..	..	..	6,000
Ground-nuts	120	1,000	..	..	..	1,120
Simsim	..	..	..	..	1,400	1,400
Potatoes	1,720	..	..	..	..	1,720
Vegetable Seeds	20	..	..	..	..	20
TOTAL	..	..	..	..	..	126,980

SEEDS SUPPLIED IN ALLEVIATION OF FAMINE DISTRESS.

PROVINCES	Kikuyu	Coast	Total
	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>
Maize	363,431	85,000	448,431
Wheat	209,431	..	209,431
Beans	129,200	..	129,200
TOTAL	..	..	787,062

IMPLEMENTS, ETC.

There is a very great increase in the number of ploughs in Kavirondo, where ploughing instructors are active, and not only that, but the natives are using their ploughs more, and turning over much land. There are areas in the Colony in which people are still using the old primitive implements, but modern implements are gradually displacing them.

CROPS.

Maize and Matama:

The Agricultural Officer at the Laboratories is working on a selection of maize named "Muratha" which should be of great value in the Kikuyu Reserve, and in the short season areas. Yellow maize on the Coast has done exceedingly well and it matures much more quickly than the usual White maize. No work has been done on a short season matama, every introduction has so far failed to satisfy. The more general growth of wheat would help to meet the requirements of the people for a short season grain crop. Steady advance may be recorded with the maize crop.

Cotton.

As to acreage planted, growth of crops, and cultivation given, one may feel that 1929 has been our record year. On the Coast the large acre yields and the fixed unvarying price throughout the buying season, together with much instruction, have induced more interest and activity. Prices paid for the 1928 crop sold and ginned in 1929 were seventeen to eighteen cents for "A" quality and seven to nine cents for "B" quality. 1,784 bales were produced in Kavirondo, and 200 on the Coast, a total of 1,984.

The 1930 estimate is 2,500 bales in Kavirondo and 500 on the Coast. Large quantities of Kenya seed cotton are carried over the border into Uganda, the ginner stating that they are unable to pay the high prices obtaining over the border.

Simsim.

The cultivation of this crop requires more attention and the value of planting in drills should be demonstrated. It is very popular on the Coast, but has not yet taken on where introduced elsewhere. Several years elapse before natives take to planting a new crop on any scale.

Groundnuts.

Largely as a result of propaganda and the imposition of the prohibition of sale as foreshadowed in the last report, a considerable improvement in quality of produce is reported from South Kavirondo. Natives still beat the husks off the nuts, so that a badly smashed sample mixed with some husk is marketed. Hand-shelling is quite as quick and gives a much more presentable sample.

Wheat.

The area under this crop is extending in Kikuyu, in some places displacing millets. In a few years we may expect a large acreage.

Beans are increasing in popularity in Meru. An effort on a large scale should be made to issue seed of one type in certain locations.

Peas.

Extension of the area under commercial types is a matter of time and effort.

Potatoes.

More extensively grown, and a large export has already developed. The cultivation of this crop is improving and in time it should become important.

Wattle Tree Planting.

This is being developed, and a rough survey of planted areas with a classification is to be made. From August to December, 933 tons of bark were sold by natives at an average price of Sh. 54 per ton. Improvements in drying are urgently needed and honesty in marketing needs to be inculcated. The crop has been introduced into Meru and is being developed about Mount Kenya.

Subterranean Roots.

Canna, cassava, and so on, are encouraged as a means of combatting famine conditions.

The reports of individual officers printed in the Appendix should be referred to.

One would take this opportunity of thanking the Administrative officers concerned for their whole-hearted support and co-operation during the year."

NATIVE LIVESTOCK.

Numbers owned by Natives (estimated).

The following figures are extracted from the Agricultural Census Report for 1929 :—

Cattle	...	...	3,280,000
Sheep	...	...	2,670,000
Goats	...	...	3,680,000
Horses	...	...	200
Mules	...	...	300
Donkeys	...	...	36,000
Camels	...	...	60,000

There is evidence to show that cattle, sheep and goats maintain a steady, if small, annual increase, but in the circumstances it is possible only to quote approximate figures.

In the interests of native tribes and in order to prevent the spread of disease from one native reserve to another, restrictions are imposed upon the movement of cattle beyond the boundaries of reserves except under control.

The limited markets available are being supplied largely with native stock. In years to come, when natives become consumers of meat, a demand, hitherto non-existent, may arise for appreciable numbers. Not until conditions radically change can there be a great incentive towards stock improvement and better management, but a beginning is being made with such resources as are available and with a limited expenditure justifiable in the circumstances to promote animal husbandry among the pastoral tribes.

NATIVE AGRICULTURAL EXPORTS.

THE ESTIMATED VALUES OF AGRICULTURAL EXPORTS OF NATIVE ORIGIN FOR THE LAST EIGHT YEARS ARE SHOWN HEREUNDER.

	1922	1923	1924	1925	1926	1927	1928	1929
	£	£	£	£	£	£	£	£
Animals ..	1,200	10,000	20,000	16,000	11,000	12,000	11,000	10,300
Copra and Coconuts ..	12,000	10,280	35,000	28,000	20,600	12,000	23,000	2,500
Cotton ..	..	..	11,860	41,000	32,750	15,000	24,000	24,800
Cotton Seed ..	..	..	..	..	..	..	..	5,400
Groundnuts ..	20,000	24,000	26,000	19,000	31,000	22,500	19,659	29,500
Maize ..	73,000	120,000	130,000	100,000	70,000	75,000	50,000	45,000
Millets ..	1,000	4,000	300	865	2,750	3,350	423	240
Pulse ..	7,000	12,000	15,000	16,000	20,400	19,900	13,000	12,500
Simsim ..	4,800	22,000	84,000	65,000	76,500	67,350	27,355	27,500
Hides ..	45,000	60,000	121,000	210,000	140,000	160,000	200,000	220,000
Skins ..	5,000	3,000	30,000	50,000	51,000	56,000	100,000	87,000
Oils—Simsim ..	..	2,400	2,200	3,000	5,500	3,550	5,000	10,000
Potatoes ..	5,000	3,000	4,000	4,000	7,250	7,500	7,000	24,000
Miscellaneous ..	1,000	1,000	1,000	1,000	2,000	2,600	2,000	2,000
TOTALS ..	176,000	271,680	480,360	564,865	470,750	497,780	482,437	500,740

It will be seen that despite lower average values of produce the total value of exports has not only been maintained but increased. In the native reserves there is evidence of substantial increase in cultivation and production. These figures do not of course reflect the annual increase in native grown products consumed locally. There is great scope for increasing native production, and the wealth so created would benefit not only the natives themselves but every other section of the community both directly and indirectly.

Note.—In the succeeding references to divisional services no attempt is made to refer to more than prominent features. For a fuller understanding of the subject and the work being carried out attention is invited to the reports of the responsible officers concerned.

VETERINARY DIVISION (EXECUTIVE).

GENERAL.

The key to the successful application of veterinary science to farming practice under the conditions obtaining in this part of the continent of Africa is research, but it is essential that means be provided for translating the results of research into such practice, and in this connexion the value and the need for services executive in kind should not be minimised.

As in past years the activities of the Department were mainly confined to the control of disease both in "settled" areas and native reserves. In native reserves an increasing confidence in modern methods of disease control is gradually becoming manifest.

EXPENDITURE AND REVENUE.

The total expenditure in respect of Veterinary Field Services during 1929 amounted to £52,317, as compared with £48,852 in 1928, and the revenue to £21,279, as compared with £16,877. The increase of revenue is attributable to the following causes: larger sales of anthrax vaccine, increased dipping fees and tuberculin tests, also quarantine fees on eighty-three animals imported, as against fifty-two in 1928.

The following table sets out the cost of Veterinary Field Services during the past six years.

	1924	1925	1926	1927	1928	1929
	£	£	£	£	£	£
Expenditure (actual ..	29,546	37,026	38,627	41,890	48,852	52,317
Revenue (actual)	11,536	24,520	25,320	22,400	16,877	21,279
Expenditure (after deducting Revenue) £	18,010	12,506	13,307	19,490	31,975	31,038

RINDERPEST.

The past year has a very low record of outbreaks save for an unfortunately large number in the Nairobi area; out of a total of sixty-six outbreaks, forty-five occurred in this area.

A successful attempt to reduce still further the ill effects of double-inoculation was made by the use of tested animals from the Veterinary Laboratory.

One district was dealt with by compulsion on the request of the local association, and there are indications that such action may be sought by other districts.

Further work in connexion with the vaccination of cattle against this disease was done in collaboration with the Research staff.

Inoculations were carried out by the Field Staff as follows.

RINDERPEST INOCULATIONS IN 1929.

	Double Inoculations	Virulent Blood Test	Serum alone inoculation	Mortality All Areas
In Settled Areas by District Staffs	49,011	78	355	..
In Settled Areas by Rinderpest Service	36,056	1,416	..	..
In Native Reserves and at Veterinary Quarantine Stations ..	65,330	7,679	46	..
TOTAL ..	150,397	9,173	401	3,177

CONTAGIOUS BOVINE PLEURO-PNEUMONIA.

This disease was reported from two places only; both of which were in one district. There were four outbreaks and the following vaccinations were carried out:—

Settled Areas	...	...	7,383
Native Reserves	...	...	5,294
Total			12,677

TICK-BORNE DISEASES.

Until there is an extensive use of fencing, and dipping is carried out efficiently as a regular practice, progress in regard to the control and elimination of losses from tick-borne diseases cannot be expected, particularly in the case of East Coast Fever. Opinion among stock-owners seems to be somewhat divided, one school of thought holding the view that safeguards afforded by control of movement should be thrown over and that herds should be built up from immunity naturally acquired, leaving those who fail voluntarily to exercise precautions to suffer the heavy losses which would ensue. Such a policy is regarded as one of despair in its application to settled areas, and it is considered that the cattle industry cannot be built up on sound economic lines faced by the risks which such a policy would involve. In native reserves the case is different and it is not a practicable proposal at this stage of development to attempt the eradication of tick-borne diseases by methods appropriate only to more advanced animal husbandry. It is hoped that when the Fencing and Cattle Cleansing Ordinances are operated, full advantage will be taken of the optional provisions and that fencing and dipping will be compulsorily applied over extensive areas of the Colony.

A valuable service is being rendered, though at considerable expense, in the immunisation of imported cattle against redwater and anaplasmosis. Unfortunately seven deaths occurred at the inoculating station within a short period. Though fully investigated by the research staff, as indicated in the report of the Research Division, the cause of the mortality remains undetermined, but it was established that it was not connected with the inoculations. This immunisation process is a complicated one and owners are apt to be impatient because of the time and expense necessarily involved, but it can be said that in no country are more up-to-date methods practised, nor could greater care be exercised.

ANTHRAX AND BLACKQUARTER.

There are no outstanding features to record in regard to these diseases.

TRYPANOSOMIASIS.

Experiments in treatment were instituted in both settled areas and native reserves. Fortunately this disease is not so great a scourge in this as in some other African countries.

RABIES.

For the first time in the history of this Colony an authentic case of the disease has been determined. A dog which had "gone mad" in the Northern Frontier Province and had bitten several persons was destroyed and on bacteriological examination of the carcass being carried out, rabies was confirmed.

MILK FEVER.

Here again, the first diagnosed case falls to be recorded. This is essentially a disease of highly productive dairy cows, and it may be assumed that, with the development of the dairy industry, this disease will become more common.

VETERINARY SERVICES IN NATIVE RESERVES.

Disease control was carried out by methods which differed according to the nature of the conditions.

Nyanza Province.

A Veterinary Officer is stationed at Maseno and is in charge of the North and Central Kavirondo Districts. He has to assist him, lay Stock Inspectors stationed at Kibigori, Maseno, Alego and Bungoma, together with trained Veterinary Scouts.

Inoculations have been undertaken against infectious and contagious diseases, and during the past five years 226,282 cattle have been dealt with, for which the natives have paid Sh. 613,818. The demands for voluntary inoculations still continue and the Kavirondo native has acquired great confidence in the protective measures. It is satisfactory to note that no case of Contagious Bovine Pleuro-pneumonia was reported during the year in Central and North Kavirondo.

Nzoia Province.

Veterinary Officer, stationed at Eldoret, in the adjoining settled area, supervises the work of a Stock Inspector stationed in the Nandi Native Reserve.

The Nandi show confidence in immunisation processes, and during the past five years have brought in, voluntarily, 45,597 cattle for inoculation and have paid Sh. 123,051 in fees.

Rift Valley Province.

A Veterinary Officer, stationed at Nakuru, in the adjoining settled area, supervises the work of a Stock Inspector stationed in the East Suk and Kamasia Native Reserve.

General inoculations have been carried out during the past five years and 59,100 cattle have been inoculated during this time, for which Sh. 146,339 has been paid. In addition many thousands of cattle have been vaccinated free for pleuropneumonia and assistance given in outbreaks of anthrax and trypanosomiasis.

Masai Province.

A Veterinary Officer was stationed in the Masai Reserve, and there are indications that this tribe are coming to appreciate the value of Veterinary Services. Reference is made elsewhere to the Ngong Training Centre situated in this Reserve.

Ukamba Province.

A Veterinary Officer with a Stock Inspector and trained native personnel are stationed in the Machakos Native Reserve.

The demands for Veterinary Services in this Reserve are variable from year to year, although 171,185 cattle have been voluntarily inoculated during the past five years, for which the natives have paid Sh. 261,783.

The Veterinary Officer visits the Kitui Native Reserve.

The second survey of the Machakos Ukamba Reserve was completed during the year.

The following summary indicates the acreage and stock population in respect of this reserve. These figures are of stock actually within the reserve at the time the census was taken, but it should be noted that at different times many of the stock are grazed elsewhere.

Acreage	Acreage Cultivated	Estimated Carrying Capacity	Cattle		Sheep	Goats
			Adults	Young Stock		
1,065,000	32,300	53,400	188,110	57,090	50,381	260,008

Northern Frontier Province.

A Stock Inspector is stationed at Isiolo and he controls the movement of stock out of the Province for trade purposes. Contagious Bovine Pleuro-pneumonia was prevalent in this area. A definite case of rabies was determined as mentioned elsewhere.

Reference is made elsewhere to the Training Centre and Sheep Experiments conducted in this Province.

Coastal Province.

Provision was made in the 1930 Estimates for staff for this area and the necessary steps were taken to make the appointment.

TRAINING CENTRES, ETC., IN NATIVE AREAS.

The scope of the training afforded in animal husbandry at Ngong, in the Masai Reserve, has been given in previous reports. Generally speaking it covers improved methods of live stock breeding and management, as well as elementary veterinary practice. New pupils have been received from the Masai and West Suk Native Reserves. From this source trained instructors should become available for employment in native schools, also in posts falling under this Department. The opportunity so afforded is being taken at this centre for procuring data with regard to the productive capacity of native cows, and a start has been made in building up an improved dairy herd by methods of selection within the native type.

At Isiolo in the Northern Frontier Province, sheep improvement services in particular are being undertaken. For this purpose a pure bred flock of Persians (black-head) was imported from South Africa. With rams of this breed, also Suffolk Downs, crossing experiments are being carried out with ewes of several distinct types of native sheep. In addition pure bred rams are available for use among native-owned flocks. Instruction will be given at this station to the pastoral tribes owning sheep largely.

A beginning has been made in the establishment of centres for giving a training to Africans in animal husbandry at Maseno, in Central Kavirondo, at Machakos, and in the Nandi Reserve.

It is hoped, through the influence and teaching of those training centres, that, in the course of time, the pristine methods of native stockowners will gradually disappear, their

sentimental attachment to stock will be broken down, and the possession of stock will be looked upon from an economic standpoint.

SLAUGHTER STOCK.

The returns in respect of stock slaughtered at Nairobi, and Mombasa, during the last four years, are appended :—

	1926		1927		1928		1929	
	Nairobi	Mombasa	Nairobi	Mombasa	Nairobi	Mombasa	Nairobi	Mombasa
Cattle	10,427	4,491	10,811	5,663	12,107	5,915	12,154	6,296
Sheep and Goats	20,901	19,457	23,685	19,910	27,610	18,988	25,657	19,043
Pigs	784	..	929	..	1,139	..	1,412	..

These figures show generally a steady progressive increase each year.

DIVISION OF VETERINARY RESEARCH.

Reference has already been made to the essential character of Veterinary Research Services. The Report of the Chief Veterinary Research Officer, of which the following is a short summary, reveals the work, creditable alike in volume and quality, carried out by the staff at the Veterinary Research Laboratory at Kabete. Consideration has been given to the establishment of a Central Veterinary Research Laboratory for Eastern Africa and representations have been made thereon.

ADMINISTRATIVE.

Correspondence.—The total number of inward, and outward letters and telegrams dealt with amounted to 5,938; in addition 6,330 reports on the result of examination of slides and specimens were typed and despatched.

Buildings.—The five staff bungalows commenced in 1928 were completed.

Water Supply.—An electrically driven well pump was installed at the borehole put down in 1928, and a new electrically driven vertical triple pump substituted for the old mule driven pump at the spring water supply. In addition, various alterations and improvements were effected in the storage tanks and distribution pipes, resulting in an ample supply of water throughout the whole year.

Fencing.—The sub-division of the grazing area into paddocks was commenced, some 4,000 yards of old fencing being dismantled and new fencing substituted.

Cold Storage Plant.—The plant indented for reached the laboratory and it is hoped to have this erected early in 1930.

FINANCE.

Expenditure.—The total sanctioned expenditure was £32,294; the actual amount spent was £38,161.

Revenue.—Revenue accruing directly to the laboratory from the sale of laboratory products totalled £18,145. The value of anti-rinderpest serum issued to the field staff for inoculation was £25,077; the revenue from such inoculations being shown under "Veterinary Inoculation Fees."

The sale of surplus livestock realised £144.

Technical Routine.—The immunisation against Fowl Typhoid and Fowl Pox of Rhode Island Red cockerels, destined for native reserves, was continued. The total number of birds dealt with amounted to 492.

TECHNICAL ROUTINE.

Slides and Specimens.

6,330 were dealt with; the result of examination is detailed in tabulated form in the report of this Institution.

Preparation of Laboratory Products.

The total quantities of serum, vaccines, etc., prepared and issued, are shown in tabulated form in the report of the Chief Veterinary Research Officer.

Anti-Rinderpest Serum.

There was a notable increase in the output; the total quantity prepared amounted to 513,555 doses, of which 340,000 doses were issued to other countries.

Rinderpest Vaccine.

15,921 doses were issued for experimental inoculations.

Blue Tongue Vaccine.

Towards the latter end of the year the demand increased, and since then till the date of completion of this report, viz. 31st March, 1930, 23,649 doses have been issued as against 7,010 doses issued during the period 1st January, 1920, to 31st December, 1928, inclusive.

Ulcerative Lymphangitis Vaccine (experimental).

There were no issues made during the year.

RESEARCH.

(A) DISEASES OF CATTLE.

Rinderpest.

The Chief Veterinary Research Officer (Mr. J. Walker) continued research on rinderpest.

The work carried out included the following, viz. :—

- (1) Serum Potency Tests;
- (2) Prophylactic Vaccination.

(1) *Serum Potency Tests.*

The results obtained from the limited number of cattle put in experiment indicate that—

- (a) The serum of actively immune non-hyperimmunised cattle is less potent than that of hyperimmunes.
- (b) The serum of cattle vaccinated with inactivated spleen extract possesses protective properties.
- (c) The serum of hyperimmunised cattle which had been in use continuously for approximately twenty months, i.e. less potent than the serum of hyperimmunes, recently included in the serum making mob.
- (d) The serum of hyperimmunised native cattle is less potent than that of hyperimmunised grades.

Potency tests previously carried out and recorded by the Chief Veterinary Research Officer, showed that the anti-serum prepared in a neighbouring territory, is less potent than the Kabete prepared anti-serum, and observations recently recorded and made by others indicate that the anti-serum prepared in another adjoining territory is of still higher potency. Variations in susceptibility of the serum makers in the three territories would appear to explain the differences in potency.

(2) *Prophylactic vaccination with inactivated toluol treated spleen extract.*

Duration of resistance conferred.—During March, April or May, 1929, several hundred head of privately owned highly susceptible cattle and some laboratory-owned unweaned calves, and cattle other than calves, were experimentally inoculated with three injections, at seven days interval, of vaccine which “blocked out” a reaction to a dose of virulent blood inoculated a few days after the last injection. Several months

later some of the above-mentioned cattle were tested on their resistance against contact infection and/or a dose of virus. The results were as follows, viz :—

(a) *Calves vaccinated prior to weaning* were not, in the majority of cases at least, resistant to contact infection or to a dose of virus approximately seven to eight months after being weaned; some mortality occurred. Re-vaccination is thus indicated after weaning.

(b) *Cattle other than highly susceptible adults* were partially protected against contact infection and inoculation of virus seven to ten months later; the resistance to inoculation of virus in highly susceptible adult cattle eight to nine months after vaccination is low and some mortality occurred. Generally speaking the resistance to contact infection is greater than to inoculation of virus.

(c) *Conferring an active immunity with inactivated spleen extract and virulent blood.*—The possibility of substituting inactivated spleen extract for anti-serum was investigated. Fresh blood was utilised with a view of eliminating a factor which could be responsible for non-reactions were other than fresh blood used. Three injections of inactivated extract, at seven days' interval, "blocks out" a reaction to a dose of blood inoculated several days after the last injection, and an active immunity is not conferred in such cases. An inoculation of a single dose of vaccine and simultaneously virulent blood being unsafe, it was decided to determine whether a reaction to rinderpest could be set up and an active immunity safely conferred by a single injection of vaccine and a subsequent dose of virus, or by two injections of vaccine at an interval between each and simultaneously with or subsequent to the second injection, a dose of virulent blood.

The most promising results were obtained with two injections of inactivated extract at seven days' interval and simultaneously with the second injection a dose of fresh virulent blood, but since the number of animals put in experiment was limited, experimental inoculation of a large number of cattle of average and high susceptibility with a pre-determined index dose of vaccine for both types of cattle should be carried out before arriving at a definite conclusion as to the safety of the method.

An observation of importance is recorded, viz. a similar quantity of inactivated extract which "blocks out" a reaction when given as three injections, at intervals of seven days, does

not necessarily "block out" a reaction when given as a single dose or as two doses at seven days' interval, the resistance being thus *built up* by successive injections.

(d) *Potency of peritoneal washings and blood respectively.*—The utilisation of tissues in addition to spleen and lymph glands would be of considerable economic importance; different workers concluded that inactivated blood possesses little or no potency. Liver extract has been found to be of little or no immunising value.

The results now recorded confirm those previously obtained, viz. inactivated blood possesses, at the dosages given, no immunising properties; peritoneal washings, at the dosage given, did not protect against a dose of virulent blood.

(e) *Keeping properties of inactivated toluol treated spleen extract.*—Toluol treated spleen extract, after storage for approximately eight months at five degrees centigrade was still potent. This observation is of practical importance as regards the storing of tested vaccine.

The Assistant Chief Veterinary Research Officer (Mr. R. Daubney) determined and recorded the immunity conferred in cattle experimentally inoculated with different types of formalinized vaccine, viz. (1) Attenuated, (2) Inactivated and (3) Inactivated and a subsequent dose of the attenuated vaccine, and carried out further field inoculations with inactivated vaccine with a view to subsequently determining the duration of resistance conferred. This worker effected improvements in the technique of vaccine production and investigated the virus content of the tissues utilised in the production of vaccine and the value of spleen and gland for hyperimmunising purposes.

With the object of ascertaining whether virus-makers, tested clean for redwater infection, harboured the parasite, splenectomy was carried out with negative results.

EAST COAST FEVER.

(1) *Artificial Transmission.*

Dr. S. H. Whitworth, Veterinary Research Officer, investigated artificial transmission by spleen pulp collected from a reacting animal in the early and late stages respectively, of the disease. Varying results were obtained. It is hoped that the investigations which are to be carried out in the near future at Kabete into the life cycle of the East

Coast Fever parasite in the animal and tick host, will result in the elucidation of the present obscure factors which play a role in artificial transmission and immunization.

Dipping and Hand-Dressing Experiments.

The results which are of practical importance in the control of East Coast Fever indicate that short interval dipping combined with hand-dressing is not effective in destroying all infective ticks which become attached to cattle exposed in a highly infected area; a percentage survive sufficiently long to transmit infection. It is the general opinion that cattle which are regularly dipped for some time prior to exposure, are more resistant to East Coast Fever than cattle which have not been regularly dipped; susceptible regularly dipped cattle contracted East Coast Fever on exposure as readily as those not dipped.

OBSERVATIONS ON REDWATER, ANAPLASMOSIS AND MUTANS INFECTIONS.

The splenectomy experiments carried out by Dr. Whitworth confirm the existence in the spleen of a mechanism which is capable of preserving a most sensitive balance in the control, "intra vitam" of these infections.

PLEURO-PNEUMONIA CONTAGIOSA BOVUM (LUNG SICKNESS OF CATTLE).

With a view of avoiding the accidents which are likely to occur from inoculation of pleuro-pneumonia virus for preventive purposes, the prophylactic value of inactivated formalinized pleuro-pneumonia infected tissue extract was investigated.

The results show that inactivated tissue extract has no protective properties even when inoculated in a large and repeated doses.

NAIROBI QUARANTINE DISEASE.

During 1929 several cases of a hitherto undescribed disease occurred at the Veterinary Quarantine Station, Nairobi, amongst cattle undergoing redwater-anaplasmosis immunization, and in one instance previous to the commencement of immunization. A Research Officer was detailed to investigate. Notwithstanding a careful and exhaustive investigation, the etiology still remains obscure.

TRYPANOSOMIASIS.

During the year the experimental treatment of cattle was carried out, under field conditions.

(B) DISEASES OF EQUINES.

Horse Sickness.

Through the kind assistance of Dr. Sir Arnold Theiler in supplying a quantity of antim-serum and virus for use in connection with the production of anti-serum, a quantity of anti-serum was prepared at Kabete in 1927, and a number of privately-owned horses successfully immunized. In view of the complications and sequelae, viz. staggers, recurrences of piroplasmosis and the risk of transmission of other infections which may sometimes occur, consequent on the serum simultaneous method of immunization and the amount of work involved in the preparation of anti-serum, prophylactic vaccination with inactivated spleen extract was investigated by Dr. Whitworth, who succeeded after creditable work in introducing a vaccine. A number of horses have been experimentally inoculated with satisfactory results and it was subsequently decided to issue the vaccine for use in the field.

(C) DISEASES OF SHEEP AND CATTLE.

Heartwater.

Observation on the natural transmission by *Amblyomma variegatum*, and the histo-pathology, were made by the Assistant Chief Veterinary Research Officer.

(D) DISEASES OF SHEEP AND GOATS.

Lailkipia Lung Disease.

Investigations were continued and the paper by Professor R. W. M. Mettam, which is included in the technical portion of the report, records our present knowledge of this disease.

(E) DISEASES OF SHEEP.

Nairobi Sheep Disease.

Investigations were commenced to determine the relationship, if any, between Heartwater and the so-called "Nairobi Sheep Disease."

(F) DISEASES OF SWINE.

East African Swine Fever.

Immunization experiments were continued by the Chief Veterinary Research Officer. Serum of hyperimmunised pigs was proved to have protective properties and may be employed for conferring an active immunity by the serum simultaneous, or a passive immunity by the serum alone method. Vaccination with inactivated spleen extract appears to confer some resistance, but not sufficient to protect, at the dosage given, against a reaction, with a percentage of mortality, to a dose of virulent blood or contact infection.

The number of experimental inoculations are insufficient to base a definite conclusion as to the prophylactic value of inactivated blood. Further work is being carried out in this connection.

Prophylactic vaccination may prove to be of assistance in immunising pigs, but owing to the lengthy period of treatment necessary it would be of little or no value in combatting outbreak of Swine Fever which spreads rapidly through the herd, and necessitates urgent intervention. The serum simultaneous or serum alone plus contact infection method is the more suitable for conferring an active immunity in already infected herds if treatment is carried out at the commencement of the outbreak, or in herds threatened with Swine Fever.

(G) PLANT POISONS.

A report on "Poisonous Plants of Kenya Colony" is submitted by Professor R. W. M. Mettam.

(H) PUBLICATIONS.

A list of papers and articles written by Veterinary Research Officers will be found in the general list of publications.

The Chief Veterinary Research Officer, during vacation leave, attended the Pan-African Agricultural and Veterinary Conference held in Pretoria in August, as one of the delegates from this Colony.

AGRICULTURAL CHEMISTRY.

The staff of the Chemical Section has been strengthened during the year by the substitution of two full-time Laboratory Assistants in place of a combined Laboratory Assistant—Junior Clerk.

Correspondence amounting to 809 inward and 554 outward letters, most of which were of an advisory nature, was dealt with. In addition to the outward letters, 673 reports upon analyses were issued.

There has again been an increase in the number of samples received. This year 1,391 samples were received, an increase of about 250 over last year.

The position as regards the accuracy of the strength of cattle dip washes remains practically unchanged. There are still too many dips being used in a dangerously incorrect state.

The coffee manurial experiments on Kasarini Estate have been continued, but owing to the lateness of the season the results are not available for this report. All the plots are carrying very heavy crops, and in some of the limed plots the crop was so heavy as to cause etiolation.

The work on the soil survey of the Colony has been prosecuted with great zeal by the Assistant Agricultural Chemist. A very large number of soil samples, taken from soil profiles exposed in almost every district in the Colony, were analysed in respect of exchangeable bases, Nitrogen content, etc., and determinations were made of their pH values. This involved an immense amount of laboratory work, and in certain instances the evolution of special technique to suit local conditions.

Field observations were made in connection with every sample taken, and the results correlated with the results of analysis. Several interesting and valuable general conclusions as regards the soil types of Kenya have been made, and will shortly be published *in extenso*, in the form of a Bulletin.

A relationship between soil conditions and the incidence of mealy-bug infestation has been discovered. Field experiments to ascertain whether it will be possible to prevent infestation by mealy-bug by manurial treatment have been laid out on a number of plantations.

It is believed also that soil conditions may also influence the incidence of Coffee Berry Disease. To test the matter a series of experiments have been designed.

The Kresotow problem has been further investigated during the year. A specification which, if followed, will always give a satisfactory product, has been evolved. It has not been possible to find a satisfactory substitute for the coal tar product; the ant repellant properties are inherent to the coal tar.

The investigation into the fermentation of coffee has been conducted to a satisfactory conclusion. By using inoculants prepared by fermenting a small amount of coffee with a culture of bacteria isolated from fermented coffee, an appreciable hastening of the fermentation has been secured in most cases. An improvement in liquoring quality has also been secured.

In order to explore the feasibility of introducing other economic crops, a certain amount of work upon essential oils has been done. There is distinct promise that some will prove profitable lines to follow.

A cheap pyrotechnic mixture for the production of a smoke screen to keep flying locusts on the wing has been evolved.

Among minor pieces of work undertaken may be mentioned the bleaching of sisal fibre, the preparation of insecticidal sprays, the evolution of an artificial food capable of maintaining ladybirds and the analysis of stock fodders.

ENTOMOLOGY.

During the year the staff of the Entomological section was strengthened by the addition of an Entomologist, an Insectaries Manager and one Storekeeper-Clerk.

Correspondence (2,500 letters).—The examination of and reporting on samples of damaged seeds, plants, flowers and vegetables, examination of plant imports, the certification of plants for export, interviews with visitors and general routine have taken up a very considerable part of the Senior Entomologist's time.

Two Entomologists (Dr. James and Dr. Le Pelley), have been almost exclusively engaged in research into the bionomics and control of the Coffee Mealy-bugs, their attendant ants and predators.

Methods of banding, and different types of repellent have been studied, and a pamphlet giving the results of these investigations is in course of preparation.

It is now definitely recommended that adhesives should not be used save as a last resort, owing to the danger, especially if their use becomes widespread, of bringing about results inimical to efficient biological control.

Insectaries for the breeding of predators have been built and, under the control of the Insectaries Manager, have made considerable progress. This work has been seriously handicapped by the very slow development of the mealy-bug during the months since it was begun. Extra food was collected when and wherever possible, but, even so, it has been difficult to maintain an adequate food supply for the adults and larvae of the ladybirds. With the help of the Agricultural Chemist, artificial food was prepared and tried but this was only very partially successful.

During the *Stephanoderes* Campaign, the Administrative and cultural side of which has been dealt with elsewhere, practically all the material collected by Inspectors was examined by the Senior Entomologist, who confirmed or

corrected the diagnosis of the Inspectors. Counts were made, involving the examination of 133,324 beans, of which 88.25 per cent showed no insect damage, the remainder showing Borer damage of one kind or another. An interesting feature of this examination was the discovery of the wide distribution of the Longicorn beetle, *Sophronica ventralis*.

At the present stage of investigation, it would appear that *Stephanoderes* is indigenous, although it has not been found attacking the wild Nandi coffee, nor is it known to infest any plant other than coffee.

The following table indicates the districts infested, and the percentage infection in samples of dry coffee (the beetles were never found in green, ripening or ripe cherries) received from them :—

District				<i>Stephanoderes</i> per cent	<i>Sophronica</i> per cent
Kiambu	...	...	...	0.7	9.2
Ruiru	...	...	...	1.3	4.1
Thika	...	...	...	1.1	1.3
Makuyu	...	...	...	0.07	1.2
Kaimosi	...	...	...	8.2	0.1
Sotik, Kericho			...	7.8	1.7
Nairobi, Ngong	...	...	...		17.2
Upper Kiambu, Limuru			...		7.4
Trans Nzoia	...	...	...		2.1

A large scale map was prepared showing the coffee areas of the Kikuyu Province, on which the distribution of all known coffee pests is marked.

One Entomologist (Mr. Wilkinson) has been stationed in Nakuru, investigating cereal pests and their control. It would appear that maize suffers but little from cutworm attacks when the seed is planted within about three weeks of the advent of the rains, and many growers are increasing their equipment in order to ensure that planting may not be unduly delayed.

The Maize Stalk Borer "Clean-Up" Campaign carried out during 1928 was so successful that during the year under review it was not necessary to apply the Rules, the pest making its appearance only in a few isolated areas where only slight damage was caused.

It is considered that this method of control is by far the most economical that could be practised in this country, and provided that stringent measures are taken every few years there should be no danger of serious losses from the pest.

A large scale pest distribution map, on the lines of that prepared for coffee, has been made in connection with cereal pests.

MYCOLOGY.

During the year tours have been made throughout Kenya chiefly in connection with sugar, maize and coffee diseases. On these tours eighty-one farms were visited and five lectures to farmers' organisations were given. Inward letters numbered 774, outward 597.

Investigations connected with stem rust of wheat were continued with vigour but failed to discover any further new physiologic forms of the rust. The number of such forms known to occur in Kenya thus remains at two. A great deal of routine testing of new hybrid selections and other wheat varieties was undertaken to assist the Plant Breeder in his work, the reactions of 170 varieties to both rust forms having been determined.

Work on coffee diseases consisted mainly of field investigations, but this was supplemented by laboratory research. Further evidence pointing to soil factors as a probable predisposing cause of berry disease was accumulated and it is hoped that it will soon be possible to obtain a systematic soil investigation in connection with the disease. A disease of coffee berries, apparently new to science, was under examination, as a result of which the fungus which causes it has been determined with practical certainty. The indications, however, are that the disease is not of major importance.

Considerable attention was given to maize diseases during the year, both in the field and in the laboratory. Valuable information has thus been obtained in connection with leaf blight and ear rot, and the list of fungi known to attack maize in Kenya has been extended by the discovery of various species on seed, leaf and stalk material from different parts of the country. The fungus causing the important "dry rot" disease was found for the first time, on a dead maize stalk. It is not yet known on the living host in Kenya.

Other research was carried out on diseases of barley and sisal.

The Sugar Mosaic Disease Campaign has resulted in greatly reducing the amount of the disease present in the country. Only a trace, in rogues of susceptible varieties, is now known to exist and it is hoped to eradicate this in the near future.

Greater losses than usual from crop diseases occurred in 1929, leaf blight and head smut of maize, coffee berry disease, wheat stem rust and barley smut all being destructive in particular districts.

With the support and assistance of farmers' associations and the co-operation of Administrative Officers in the areas affected, it is proposed to carry out an anti-striga campaign during 1930 and preliminary arrangements have already been made.

A list of new fungus records obtained in 1929 includes a number parasitic on the chief crops of the country.

A special visit was made to South Africa in July and August in order to attend the Pan-African Agricultural and Veterinary Conference. In addition to attending the Conference and taking part in the discussions, several visits were made to a number of scientific institutions connected with agriculture in South Africa.

PLANT BREEDING AND NJORO EXPERIMENT STATION.

Of outstanding importance has been the production in bulk of the new wheat bred by this Department, B.286. It is generally speaking a strong strawed wheat and possesses very close chaff. Its yielding capacity in the field is about the same as Kenya Governor. As regards rust resistance, B.286 is highly resistant to both physiologic forms of Stem Rust. It is, unfortunately, not sufficiently resistant to Yellow Rust to be grown at the higher and colder altitudes of 8,000 feet and over. It may sometimes suffer a certain amount of damage from Leaf or Brown Rust. Its baking qualities have been reported as being satisfactory and are distinctly better than those of Kenya Governor—Equator flour. This wheat will in future be called Kenya Standard. The price per bag of 200 lb. of seed has been fixed at Sh. 25 for the year 1930, and there are approximately 4,500 bags available for sowing in that year.

High altitude wheat areas are still without a suitable variety. Wheats now have to be resistant not only to Yellow Rust but also to Stem Rust to be of use at high altitudes. Equator, the main wheat grown, is always liable to be attacked by Stem Rust. It was hoped that the Njoro hybrid wheats would take the place of Equator and that they would be in sufficient bulk for general use by 1932. The position is now more doubtful. Most of these wheats are not sufficiently resistant to Yellow Rust at the higher altitudes, as the Njoro (where they were bred) and sometimes even the Mau Summit Stations are not sufficiently severe testing places for the resistance of wheats to this rust. There are still a few left, however, of which hopes are entertained. Some of these have already been multiplied by farmers, and others will be issued in 1930. Some of these which are "club" wheats may be of value and may temporarily solve the problem of wheat growing at the higher altitudes as did Kenya Governor at the lower.

In Equator and some of the types discovered in Australian Florence, wheats have been found which are immune to Yellow Rust. Crosses have been made between these wheats and some of the locally bred wheats which are now definitely known to be resistant to both physiologic forms of Stem Rust. The progeny of the cross between Florence and B286 will be grown twice a year at the Scott Agricultural Laboratories so that results may be available to farmers in the shortest possible space of time.

The maize breeding work begun in 1928 was continued at Njoro. Selection in the field was done in breeding plots and ear-to-row tests were made. A severe infection of ear-rot was experienced. A breeding plot was planted with seed from the Kenya "Flat White" Maize previously bred at the Scott Agricultural Laboratories. Selections in the field were made and it is possible that a heavy yielding strain may be worked up from these selections.

Climatic conditions have not proved ideal for maize breeding at Njoro and this year the plots will be situated nearer to the reservoir so that they can be irrigated if the necessity arises. They will also be manured. Seed maize from the Njoro breeding plots will also be tested out in the Solai maize belt to observe the result when it is grown at an altitude of 1,000 feet lower.

The work started last year on producing a variety of maize resistant to " White Blight " has been continued in the Trans Nzoia and results obtained so far seem very promising. Plants grown from the original resistant seed (selected in 1928) have proved highly resistant to the disease this year.

Fertiliser experiments were continued at Njoro. The Phosphatic strip experiments on wheat and maize proved of great interest to visiting farmers and showed the value of phosphates for these two crops. The Potash and Phosphatic strip experiment showed that, at Njoro, Potash had no effect whilst an application of 50 lb. only of Superphosphate gave results. The accurately designed chessboard experiment demonstrated the value of Phosphatic fertilisers at Njoro, and that Potash, Nitrogen and Lime by themselves had no effect.

The cereal crop trials have striking results this year. Early sowing of wheat was shown to be advisable and under such conditions it appears to be a better economic crop at Njoro than any other cereal, unless it be possible to produce a good malting sample of barley.

Good and ragged stands of maize were planted and the importance of a good stand was clearly demonstrated by the yield obtained from the respective plots.

SCOTT AGRICULTURAL LABORATORIES.

The need for improved and extended accommodation has become a pressing one. In this connection the Agricultural Commission reported as follows :—

" With the extension of the scientific staff of the Department, the need for better laboratory accommodation is urgent. The Scott Laboratories have been improvised in a building quite unsuited for the purpose and are inadequate to the present staff. The Commission recommends that an entirely new range of buildings should be provided on this or some alternative site at as early a date as the financial position of the Colony permits."

Somewhat deficient rainfall early in the year was amply made up by the short rains which were very heavy, and brought the annual total to a point 8.37 inches above the average.

Crops were on the whole good, although heavy rains late in the season will delay the maturing of the short rains plantings.

Experimental work on maize included an investigation into the effects of different kinds of seed treatment, observations on Leaf Blight, and the continued selection work on the type known as "Muratha," which is a flat white maize of a quick-growing habit specially suited to the conditions of the Kikuyu Province where two crops are taken in the year.

The area under coffee has been increased during the year, and much experimental work, including variety trials, green and other manuring, pruning and shade trials (both natural and artificial), as well as work on irrigation and the production of a hardy "local" strain of "bronze-tipped" coffee by selection methods, and experimental work on propagation by vegetative methods, is being carried out under the direction of the Senior Coffee Officer, a report of which will be found under the section dealing with this crop.

A large amount of work has been done in connection with wheat breeding, a new and much enlarged "cage" having been erected, in which hybrids were grown for selection. Yield trials of new pure strains were carried out, and advantage is taken of the two seasons to multiply other pure strains for issue, thus saving much time, as at the Plant Breeding Station at Njoro, only one crop can be taken in the year. An accurate yield trial was also carried out to determine the comparative yielding capacity of B286, B286 C (a pure line of the former wheat) and Kenya Governor, which was grown as a control.

The rotation experiments which were commenced in 1928 have been continued, and certain interesting results have been observed.

A series of trial plots of various green manure crops, both indigenous and exotic, were planted out, and observations and weighings taken. Outstanding crops are Cowpeas, Njahi, Koinyangu Lupin, Niger Oil, Crotalaria incana, and Wedge Pea. This is the fifth repetition of these trials and a mass of interesting data has been accumulated.

The plots of forage grasses have attracted much attention from visitors, and have yielded further information as to their growth characteristics and value as pasturage. *Pnacium coloratum* provides a fine succulent feed, and, with its drought resisting powers, is considered the best grass yet tried, although *Paspalum dilatatum* is also promising. Observations were made on plots of pure sowings of grasses, in the cattle

boma, and also on a series of specially treated plots of virgin pasture on land adjacent to the Laboratories, the property of the Education Department.

Over one hundred new crops of possible economic value have been planted out for trial and observation, and trials of others, such as tea, salt bushes, *Erythroxylon coca* (yielding cocaine) and *Boehmeria nivea* (ramie fibre) have been continued. The Yerba Mate trees have made healthy growth, but there is ample evidence that they would respond freely to a considerably higher rainfall, and that such is, in fact, necessary for them to prove of value as a commercial crop. The plants of the Kudzu vine have now become well established, and it shows some promise of being a useful cover crop. *Edible Canna* has been the centre of much interest to farmers during the year, and twenty-five issues of roots for trial have been made.

A number of American varieties of Sorghum were grown in comparison with the local variety "White Kikuyu." Unfortunately, these were all killed off by a bad attack of rust and other fungous diseases, and no crop was obtained. The local variety, although it suffered heavily, succeeded in producing a small crop.

Lucerne variety trials were continued, the following varieties having proved themselves to be far outstanding: Hairy Peruvian, Hunter River and Cape Province.

Soya Beans were successfully grown for the first time, with the aid of an inoculant culture received from America, but although nodule formation was fairly satisfactory, the growth and yield were poor. It is possible, however, that with acclimatisation the crop may become a profitable one.

An excellent crop of rye was grown, yielding ten bags to the acre.

A plot of *Pyrethrum* has been planted out, and is making satisfactory growth, although it is as yet showing no signs of flowering. Its behaviour is being watched with great interest, since, if it proves a success, it will do much to lessen the burden of pest control, by enabling planters to produce their own insecticide.

Potatoes have been grown in bulk for sale for seed purposes. The seed, however, is beginning to deteriorate, owing to virus diseases, and a fresh supply, including those

varieties which have been found by trial to be most satisfactory, and also certain successful new varieties, has been ordered from Scotland for planting in the long rains, 1930.

One qualitative experiment with different types of Phosphatic fertilisers, and one quantitative experiment with Superphosphate have been laid down, in the form of "Latin Squares." Observations have been made on the residual effects of the experiment carried out last year with Seychelles Guano. In collaboration with the Agricultural Chemist an experiment is being carried out to determine the effects of continual green manuring on the physical condition of the soil, and also trials have been conducted with a view to determining the most economical method of preparing artificial farmyard manure. A plot of barley has been grown for the Mycologist to test the relative efficacy of different methods of seed treatment against Covered Smut (*Ustilago hordei*).

Work on the farm is done mainly by the apprentices who are receiving training in elementary agriculture at the School, and in this connection one plot is laid out as a model native *shamba*, demonstrating suitable rotations and general lay-out. Apprentices are also provided with gardens which they cultivate in competition for an annual prize.

The range of poultry runs has received much attention during the year, and a number of new houses have been made. 900 chicks were hatched out and 350 birds were issued to Native Reserves for the improvement of the native stock.

In response to the continued demand, over four hundred lots of different seeds were sent out to farmers for trial purposes.

Additions to buildings during the year consisted of new quarters for the African pupils at the Agricultural School, and African employees, costing approximately £2,150.

Four complete insectary units, comprising eight separate houses, were erected at a cost of £6,014.

A small coffee factory, designed to handle the coffee from a large number of plots, was constructed at a cost of approximately £540.

GRADING AND INSPECTION (IMPORTS AND EXPORTS)
 ALSO
 GRAIN CONDITIONING AND COOL STORES
 SERVICES.

Since the inception of the Grading and Conditioning Services careful accounts have been kept, and for the year ending 30th June, 1929, the Grading Service showed a Credit Balance of Sh. 27,663/51, while the Conditioning Plant showed Sh. 5,634/84 in credit.

The Grading Account, since November, 1923, shows a credit balance to date of Sh. 78,886/64, and the Conditioning Plant, which was opened in 1925, has a nett credit balance to date of Sh. 4,090/36, or a total of Sh. 82,977 on the combined services, which is being accumulated to meet interest and sinking fund charges on the capital cost of £10,743 on the Grain Conditioning Plant.

Plant Import Inspection.

16,295 packages of seeds, plants and fruit were passed, having a declared value of Sh. 681,824/12. In addition seventy-four packages value Sh. 1,494/30 were passed in transit to Uganda.

A new fumigating shed was built by the Port Authorities and handed over to the Department on December 28th, 1929.

GRADING AND CONDITIONING.

Maize.

450,420 bags were graded during the year, being a decrease of 3.3 per cent on the previous year.

No maize of ordinary "native" type was presented for grading; exports of maize of this grade were made chiefly to Benadir Ports.

The slight decrease is attributed to two main causes:—

- (1) restriction of surplus for export by the Food Control Board;
- (2) no maize was exported from the 1929 planted crop.

Shipments.—117 Export Certificates were issued for 373,698 bags of maize, comprising:—

- 216,988 bags of K.2 shipped in bags.
- 154,449 bags of K.2 shipped in bulk.
- 1,134 bags of K.3 shipped in bags.
- 1,127 bags of K.6 shipped in bags.

Rule 25.—31,064 bags were shipped to East African Ports as permitted without a certificate, showing a reduction of 71. per cent on the previous year's figure.

After consideration at the Joint Maize and Wheat Consulting Committee, it was decided to introduce Inland Grading Services for wheat and maize at the two centres Kitale and Nakuru. Amended Rules were accordingly promulgated to give effect to this proposal, and preliminary arrangements were made for the inception of the system early in 1930. At the same time certain reductions were made in the grading charges to take effect in 1930, the revised rates being five cents per bag at the Coast, and six cents at inland centres for maize, and six cents and seven cents respectively for wheat.

Maize Conditioning.

49,239 bags of wet maize were treated at the plant, being an increase of 5.5 per cent over the previous year's total of 46,656.

No maize was treated for the destruction of weevils.

No consignments were sent direct to the Conditioning Plant from up-country stations.

Wheat Grading.

35,302 bags of wheat were received for grading, but owing to re-grading at the Conditioning Plant after treatment, a total of 53,145 bags were graded. The first quoted figure was comprised as follows:—

Equator : 26,250 bags ; 74.35 per cent of total received.

Kenya Governor : 5,347 bags ; 15.14 per cent of total received.

Durum : 3,705 bags, 10.5 per cent of total received.

15,896 bags were rejected as wet, being 45 per cent of the total received.

Shipments.—Seventy Export Certificates were issued for 54,158 bags of wheat as follows:—

27,444 bags First Grade (K.1.).

6,700 bags Second Grade (K.2.).

6 bags Third Grade (K.3.)

8 bags First Grade S.W. (K.1SW).

Wheat was exported to South Africa, India, Europe and to Ports on the East Coast of Africa.

Wheat Conditioning.

18,429 bags of wet wheat were treated at the plant, a decrease of 13 per cent on last year's figures of 21,155 bags.

No consignments of wet wheat were sent direct to the plant from up-country stations.

A new "Cradley" vertical boiler was installed at the Conditioning Plant.

Potatoes.

67,503 cwt. were presented for grading, an increase of 51.9 per cent over the previous year's total.

Approximately 88 per cent were consigned to Bombay.

The principal defects were :—

- (i) High proportion of mechanically injured tubers.
- (ii) Unripe and green potatoes.

Beans.

4,323 bags of beans were inspected on request by shippers.

Cool Stores.

More use was again made of the Cool Stores during the year.

The following commodities were deposited :—

Fruit	...	...	155,180 lb.
Fresh Fish	...	...	31,857 lb.
Cured Fish	...	...	64,990 lb.
Cheese	...	...	4,037 lb.
Offal	...	...	5,528 lb.
Poultry	...	...	48 $\frac{2}{3}$ dozen
Butter	...	...	3,405 lb.
Beef	...	...	301 quarters.
Mutton and Pork...	...	...	212 carcasses
Eggs	...	...	270 doz.
Ham and Bacon	...	...	692 lb.
Vegetables	...	...	3,702 lb.

Other Commodities.

- 10 drums—60 gallons Beer.
- 20 lb. Lard.
- 30 lb. Yeast.
- 10 lb. Orange Peel and Walnuts.
- 62 lb. Cream.
- 480 lb. Margarine.
- 3 bottles Milk.

In order to reduce the risk of breakdown in the "Cool Stores" Plant to a minimum, certain essential machinery was duplicated.

FISHERIES.

Consequent on Mr. Graham's survey of Lake Fisheries, mentioned in my Report for 1928, the "Victoria Nyanza Fish Protection (Amendment) Rules, 1929," were promulgated and came into force on June 1st. These Rules regulate and control the types of fishing net used, with the object of protecting those species of fish which are of marketable value.

The question of imposing further control on the methods of fishing, with the same end in view, is receiving consideration.

With reference to Sea Fisheries, attention is being given to the most satisfactory method of giving effect to the recommendations contained in Dr. Von Bonde's report. Detailed enquiries have been made into the probable cost of a further and more extensive survey of the coastal fishing grounds.

LOCUST CAMPAIGN.

In January, 1929, locust staff and equipment were increased and operations in the Second Hopper Campaign intensified, particularly in the Kerio and Ukamba Provinces, whilst operations on a smaller scale were being carried out in the Coast Province, the Northern Frontier and the Masai Reserve.

The work of hopper destruction terminated at the end of January, and the flying swarms which arose from the undisturbed areas in the Northern Frontier Province and Tanaland flew south after doing considerable damage to crops in the Meru and Embu districts. These swarms eventually entered Tanganyika Territory in a series of waves early in February. Swarms which escaped destruction in Turkana and Kerio also flew south over the Plateau and Trans Nzoia.

In April, maturing swarms began to fly north, first appearing at Voi and in the Masai Reserve. Later, large locust concentrations were reported in the Nandi country, at Thompson's Falls and at Ngobit. Damage was done to wheat, sisal, coconuts and bananas. The above concentrations were attacked by flame-throwing units but it was found that the amount of destruction done was not commensurate with the large expenditure which it entailed. The units were therefore withdrawn and the personnel formed the nucleus of a large scouting organisation preparatory to the Third Hopper Campaign.

Reports of laying were received from the Masai Reserve, Machakos, Voi, Gilgil, Embu and the Kerio Province generally, and the scouting staff were augmented early in May by the posting of further officers, supplies and equipment; a locust train was also despatched for anti-hopper work on the Voi-Kahe line. By the end of May twenty-eight trucks and forty-eight officers were in the field. The Gilgil area of 15,000 acres infestation was under control in fourteen days and hoppers in Kitui and Machakos districts were cleared up in a shorter time.

At the end of May the hopper infestation in North and South Turkana, Maramoja (Uganda), Suk country and Elgeyo and Maraquet was such that further locust staff had to be enlisted. These officers were recruited from the Trans Nzoia and Plateau districts and by the 15th June there were fifty Temporary Locust Officers operating in the Kerio Province. Hoppers were being destroyed by burning in Turkana and by spraying and bran baiting elsewhere.

The infestation in the Masai Reserve was fairly extensive and fourteen officers were employed in the work of destruction; on 15th June an extra locust train was assembled for operations on the Magadi railway line. By the end of June the infestation was under control and practically all hoppers were destroyed in an area of 6,000 square miles by the end of July.

In the Voi district during the first few days of July, fresh hatchings were reported and the staff had to be reinforced for working this difficult bush country from which some hoppers eventually escaped. Other hoppers reached maturity in the Uasin Gishu, Masai Reserve bordering the Baringo district, whilst complete destruction could not be effected in North Barindo, Karamoja and Turkana generally.

Even although the infestation in the Northern Frontier Province was on a very small scale, it was expected that flying swarms would arise in the South and Tanganyika and that the general direction of flight would have a tendency to the North.

By the middle of July there were one hundred officers in the field, a fact which necessitated a good supply and transport organisation. There were very large hopper bands reported North of Moyale in Abyssinia, but although flying swarms were reported from various places in the Colony, there was no damage done to crops.

The middle of August saw the commencement of a reduction in staff, although it was realised that anti-hopper operations would not definitely cease, especially in view of the fresh laying that had taken place in South Turkana, on both banks of the Turkwell and Kerio Rivers, and in Baringo by gravid swarms that had entered these localities from the Sudan and round the Southern end of Lake Rudolf. Young hoppers appeared at the end of August and efforts were made to clear the areas rapidly. Except in Baringo, this was not entirely accomplished owing to the intensity of the infestation and local restrictions imposed on baiting and spraying. Three large swarms escaped in North and South Turkana. By 10th October, 1929, the locust field staff was reduced to a scouting nucleus of thirteen temporary officers from some of whose reports at the end of October, it was indicated that the Colony had once again been invaded by gravid swarms from the north and that laying was taking place in the Northern Frontier Province, Meru, Embu, Kitui and Voi Districts.

During November and December further staff had to be enrolled and a total of twenty-seven officers were operating.

The Northern Frontier Province infestations covered an area of 900 square miles, mainly in the vicinity of Archer's Post, and in spite of labour shortage, successful operations are being carried out with bran-bait, which is the only means of destruction now being used.

In Embu the control of operations is under the Assistant Agricultural Officer who, with four temporary officers, is carrying out successful baiting operations over a large infested area.

In the Kitui district hoppers appeared in the Mumoni Location, on the Yatta Plains and in the vicinity of Mui and Nuu, and eight officers are now at work.

Small infestations near Donyo Sabuk and in the Machakos district have been cleared up and the staff transferred, whilst in Voi two officers and a locust train are still operating.

Prospects for 1930 are favourable and unless flying swarms again appear from the north, the infestation in June resulting from the very few escapes in the present campaign will be slight.

AGRICULTURAL SHOWS.

An agricultural show was held at Nakuru during the first week in December, under the auspices of the Royal Agricultural and Horticultural Society of Kenya.

This show, both in the interest taken in it, and in the quality of the exhibits, whether for exhibition or competition, was a marked success.

This is the more noteworthy in that the agricultural conditions which obtained during the year were scarcely favourable to the holding of a show on such a large scale.

The Department staged a comprehensive exhibit which was of value both educationally and as illustrating the recent departmental activities.

For purposes of display at an exhibition held at Dar-es-Salaam, this Department, with the assistance of those engaged in the several industries, organised an exhibit representative of the Colony, including also illustrations of departmental activities.

No native agricultural shows were held during the year on account of the unfavourable conditions in respect of crops prevailing in native reserves.

As in previous years, Government made a Grant-in-Aid of £500 to the Royal Agricultural and Horticultural Society.

LAND SETTLEMENT.

As already stated, the net increase in the number of European occupiers of holdings was sixty-four, and allowing for changes in occupation the total increase of new occupiers was 133.

The position was reviewed in my last Annual Report and it has unfortunately not improved in the interim. Much time is necessarily occupied before farming pursuits become settled in their stride and, taking the long view, occasional set-backs are not without advantage though individuals may suffer in the process. The case of a comparatively small proportion of the farm bearing the interest burden of the whole was discussed in my last report. As time has passed another unsatisfactory situation has arisen. In many cases the mortgage bond or bank overdraft has reached such a figure that further financial facilities are restricted, and the position is that in the absence of an extension of development the property cannot produce on a scale sufficient to place it on a sound financial basis. Here, as elsewhere, a shortage of capital for development purposes has been proved to be a real deterrent to successful settlement. Insufficient capital for development purposes, and as a reserve to meet the consequences of

periodic crop failures, improvident borrowings at high rates of interest, inexperience and uneconomic management, are all contributory causes to non-success. But the Colony of Kenya is not peculiar in those respects and its natural resources coupled with its high productive and recuperative capacity should enable it to recover more quickly than most agricultural countries from the agricultural depression which now prevails throughout the world.

LABOUR.

The average number of men, women and children (almost entirely Africans) employed on holdings in the European areas for the last five years, are shown in the following table :—

YEAR	Men	Women	Children	Casual Daily Labour	Total
1929	85,082	4,249	15,304	6,062	110,697
1928	83,000	4,654	17,295	9,371	114,320
1927	76,838	4,802	15,428	5 006	102,074
1926	74,873	6,021	13,717	Not enu- merated	84,611
1925	61,735	5,477	11,315	ditto	78,527

The average number employed monthly showed a decrease of 3,623 as compared with the previous year, this decrease can be attributed to a lesser demand for coffee pickers, which reduced the numbers of children and casual daily labourers employed. A plentiful supply of labour appears to have been available in most districts as few reports of serious shortage were recorded. The accuracy of the predictions of the Labour Commission of 1927, which was requested to deal with the labour position and requirements until the end of 1929, have been fully exemplified by subsequent experience and actual results.

LIBRARY AND PUBLICATIONS.

The library continues to be much used by the Departmental Officers and the farming community, and issues of books on loan to subscribers appear to be appreciated by those applying for such assistance.

For some years past an effort has been made to promote a service of exchange in respect of agricultural literature, and publications of considerable value on agricultural subjects and recent research are received from other countries, and these are used to the best advantage in the Department.

The more important agricultural journals obtained by purchase and exchange are being bound and preserved for purposes of reference.

The Department was gratified to note the complimentary references by the Agricultural Commission to the quality of its publications. Having regard to the number of contributors and the resources for carrying out work of the kind which justifies publication of results, the output will compare favourably with similar publications elsewhere.

It is not a easy matter to prepare and maintain a complete mailing list without incurring waste, and the Department would welcome applications from those desirous of receiving its publications with an indication of the series desired.

Both the Department and the public are indebted to the press for the publication of a large amount of matter contributed by the Department.

The following statement shows the present circulation of departmental publications :—

Individual farmers	...	...	603
Farmers' Associations, etc.	...	...	117
Administrative Officers	...	...	64
Trading Concerns	...	...	22
Consuls	...	...	11
Departmental	...	...	32
Newspapers, etc.	...	...	13
Foreign Mailing List	...	...	489

The following reports, bulletins, etc., prepared by officers of the Department have been published during the year. The papers contributed by officers of the Department to the Pan-African Agricultural and Veterinary Conference, held at Pretoria in August, 1929, were also printed and issued as Departmental Bulletins (Nos. 7/1929 and 8/1929).

(a) *General Agriculture.*

"The Establishment of Permanent Pastures, using Cereals as Nurse Crops," by W. Lyne Watt, Cert. H.A.S., Forestry. (Bulletin No. 28/1928.)

"Notes on trials of Leguminous Plants at the Scott Agricultural Laboratories," by W. Lyne Watt, Cert. H.A.S., Forestry. (Bulletin No. 1/1929.)

"Green Manures, Shelter Belts and Cover Crops," by W. Lyne Watt, Cert. H.A.S., Forestry. (Bulletin No. 2/1929.)

" A Preliminary Note on ' Silage '."

" Notes on Edible Canna (*Canna Edulis*)—Queensland Arrowroot."

Pan-African Agricultural and Veterinary Conference, 1929 :

" Wheat Breeding in Kenya," by G. J. L. Burton, M.C., B.A., Plant Breeder. (Bulletin No. 7D/1929.)

" Notes on Maize in Kenya," by J. McDonald, D.F.C., B.Sc., F.L.S., Mycologist. (Bulletin No. 7J/1929.)

(b) *Soils.*

" Soil fertility at the Scott Agricultural Laboratories," by D. S. Gracie, B.Sc. (Hons.), A.I.C., Assistant Agricultural Chemist, and W. Lyne Watt, Cert. H.A.S., Forestry, Assistant Agricultural Officer. (Bulletin No. 27/1928.)

" Preliminary Observations on some of the Soils of Kenya Colony," by D. S. Gracie, B.Sc. (Hons.), A.I.C., Assistant Agricultural Chemist. (Bulletin No. 4/1929.)

" Instructions for sampling Soil."

" Notes on Soil Analysis."

Pan-African Agricultural and Veterinary Conference, 1929 :

" Notes on a Preliminary Soil Survey of some parts of Kenya Colony," by D. S. Gracie, B.Sc., A.I.C., Assistant Agricultural Chemist. (Bulletin No. 7L/1929.)

(c) *Coffee.*

" A Report on the Campaign against *Stephanoderes*, 1929," by A. D. le Poer Trench, O.A.C. (Dip. Agric.), Senior Coffee Officer, and T. J. Anderson, M.A., B.Sc., F.Z.S., F.E.S., Entomologist. (Bulletin No. 10/1929.)

" Notes on Artificial Shade for Coffee."

" A Practical Coffee Pulping Station (with Plan)."

" Notes on Irrigation," by W. G. Leckie, B.Sc., Agricultural Officer.

" Diseases of Plants Prevention (Coffee) (Amendment) Rules, 1929.

Pan-African Agricultural and Veterinary Conference, 1929 :

" A Preliminary Note on the Fermentation of Coffee," by V. A. Beckley, M.C., M.A., A.I.C., Agricultural Chemist. (Bulletin No. 7M/1929.)

(d) *Locusts.*

" Preliminary Notes on the Control of Locusts (*Schistocerca gregaria*) : With summary of methods used in Hopper Destruction and Notes on Flying Swarms to October, 1928," by E. Harrison, M.S.A., B.Sc., N.D.A. (Hons.), Deputy Director of Agriculture. (Bulletin No. 3/1929.)

" History and Activities of Locusts in Kenya and Relative Costs of Destruction," by E. Harrison, M.S.A. (Ames.), B.Sc., N.D.A. (Hons.), Deputy Director of Agriculture. (Bulletin No. 9/1929.)

" Measures to combat the Locust Menace : the Life History and Habits of an Evil Menace," by H. Wilkinson, A.R.C.Sc., F.E.S., F.L.S., Assistant Entomologist.

" Destruction of Locust Eggs and Hoppers." (Reprint local Press, June, 1929.)

(e) *Entomology and Mycology.*

" A List of Plant Diseases in Kenya Colony," prepared by J. MacDonald, D.F.C., B.Sc., F.L.S., Mycologist. (Bulletin No. 5/1929.)

" Notes on the Use of Kresotow."

" Control of Leaf-eating Caterpillars (Coffee)."

Pan-African Agricultural and Veterinary Conference, 1929 :

" Biological Control in Kenya Colony ; with special reference to the problems of the Common Coffee Mealybug (*Pseudococcus lilacinus*, *Ckll.*)," by H. C. James, Ph.D., B.Sc., N.D.A., N.D.D., Assistant Entomologist. (Bulletin No. 7E/1929.)

" Control of Maize Stalk Borers," by T. J. Anderson, M.A., B.Sc., F.Z.S., F.E.S., Entomologist. (Bulletin No. 7F/1929.)

" Notes on Physiologic forms of Wheat Stem Rust in Kenya, and their bearing on Wheat Breeding," by J. McDonald, D.F.C., B.Sc., F.L.S., Mycologist. (Bulletin No. 7G/1929.)

" Notes on Diseases of Coffee in Kenya," by J. McDonald, D.F.C., B.Sc., F.L.S., Mycologist. (Bulletin No. 7E/1929.)

(f) *Veterinary.*

Pan-African Agricultural and Veterinary Conference, 1929 :

- “ Rinderpest Research in Kenya,” by J. Walker, M.R.C.V.S., Chief Veterinary Research Officer. (Bulletin No. 8A/1929.)
- “ Prophylactic Vaccination against Rinderpest,” by R. Daubney, M.Sc., M.R.C.V.S., Assistant Chief Veterinary Research Officer. (Bulletin No. 8B/1929.)
- “ Pleuro-pneumonia contagious bovum,” by J. Walker, M.R.C.V.S., Chief Veterinary Research Officer. (Bulletin No. 8C/1929.)
- “ Memorandum of Horse Sickness Immunisation,” by S. H. Whitworth, B.C.Sc. (Melb.), D.V. (Zur.), M.R.C.V.S., Veterinary Research Officer. (Bulletin No. 8D/1929.)
- “ Contagious Pleuro-pneumonia of Goats in East Africa,” by R. W. M. Mettam, M.Sc., M.R.C.V.S., Veterinary Research Officer. (Bulletin No. 8E/1929.)
- “ East Coast Fever : Artificial Immunisation and Immunity in their relations to the Control of East Coast Fever,” by J. Walker, M.R.C.V.S., Chief Veterinary Research Officer, and S. H. Whitworth, B.V.Sc., D.V., M.R.C.V.S., Veterinary Research Officer. (Bulletin No. 8F/1929.)
- “ Memorandum on Research on East African Swine Fever Immunisation in Kenya,” by J. Walker, M.R.C.V.S., Chief Veterinary Research Officer. (Bulletin No. 8G/1929.)
- “ Veterinary Education with particular reference to State Services in the Tropics,” by R. Daubney, M.Sc., M.R.C.V.S., Assistant Chief Veterinary Research Officer, and R. W. M. Mettam, M.Sc., M.R.C.V.S., Veterinary Research Officer. (Bulletin No. 8H/1929.)
- “ Veterinary Education of Natives,” by Lieut.-Col. A. G. Doherty, M.R.C.V.S., late Chief Veterinary Officer. (Bulletin No. 8J/1929.)

(g) *General.*

- “ Annual Report of the Department of Agriculture for the year 1928.”
- “ Agricultural Census, Ninth Report, 1928.”
- “ Crop Reports—January, February, March, August, September, October, November, December, 1929.”

"The Utilisation of Sisal Waste for the Production of Power Alcohol," by V. A. Beckley, M.C., M.A., A.I.C., Agricultural Chemist. (Bulletin No. 6/1929.)

Report of Proceedings of the First Pig Industry Conference, April, 1929.

"A Short Guide to the activities of the Scott Agricultural Laboratories." (Revised July, 1929.)

"A Short Guide to the activities of the Plant Breeding Station, Njoro, July, 1929."

"Some Notes on Agricultural Work for District Associations," by E. Harrison, M.S.A., B.Sc., N.D.A., Deputy Director of Agriculture.

"Short Record of Research and Experimental Work, 1929."

"Short Account of the History and Activities of the Department of Agriculture, Kenya."

"Notes on Ghee."

"Notes on the Preparation of Hides and Skins for Export."

Pan-African Agricultural and Veterinary Conference, 1929 :

"The Need for Cost Accounting as indicated by a preliminary enquiry into the Cost of Production of Coffee in Kenya," by D. L. Blunt, M.A., Senior Agricultural Officer. (Bulletin No. 7A/1929.)

AGRICULTURAL LEGISLATION.

The following Ordinances and Rules under existing Ordinances, affecting the Agricultural Industry, were promulgated during the year :—

Grading of Maize Rules, 1929.

Grading of Wheat Rules, 1929.

Damage by Locusts Ordinance, 1929.

Kerosene Oil (Repayment of Duty) (Amendment) Ordinance, 1929.

Stock and Produce Theft (Amendment) Ordinance, 1929.

Diseases of Animals (Amendment) Rules, 1929.

Diseases of Plants (Coffee) (Amendment) Rules, 1929.

Victoria Nyanza Fish Protection Rules, 1929.

Stock Traders Licence (Amendment) Ordinance, 1929.

The Crops and Livestock Production Ordinance, 1927
(Groundnut (Marketing) Rules, 1929).

An immense amount of work was done by the Select Committee and also Departmentally on the Bills dealing with the Fencing of Farm Holdings and Cattle Cleansing, both of which eventually passed their third reading at the end of the year. The Land and Agricultural Bank Bill also occupied a good deal of time.

VISIT OF BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Among the visitors were several distinguished in agriculture and the sciences related thereto. While they were impressed with the complexity of the problems affecting the agricultural industry, one and all were greatly impressed with the progress already made in agricultural production and the development of agricultural industries. It may not be unfitting also to record in this report that they spoke in the highest terms of the work which is being done by the scientific and technical officers of this Department, and expressed some surprise to find the organisation of such work being carried out along lines so up to date, having regard to the stage of the Colony's existence and the extent of its resources.

DEPARTMENTAL REPORTS.

Submitted with this report are included the following appendices :—

- (a) Staff changes and new appointments in 1929.
- (b) Staff at December 31st, 1929.
- (c) Annual Report of the Chief Veterinary Officer.
- (d) Annual Report of the Chief Veterinary Research Officer.
- (e) Annual Report of the Agricultural Chemist.
- (f) Annual Report of the Senior Entomologist.
- (g) Annual Report of the Mycologist.
- (h) Annual Report of the Plant Breeder.
- (i) Annual Report of the Senior Coffee Officer.
- (j) Annual Report of the Live Stock Officer.
- (k) Annual Report of the Chief Grader and Inspector.
- (l) Annual Report of the Locust Officer.
- (m) Annual Report of the Assistant Agricultural Officer, Nakuru.
- (n) Annual Report of the Agricultural Officer, Eldoret.

- (o) Annual Report of the Agricultural Officer, Scott Agricultural Laboratories.
- (p) Annual Report of the Agricultural Officer, South Kikuyu.
- (q) Annual Report of the Assistant Agricultural Officer, Embu and South Nyeri Districts.
- (r) Annual Report of the Assistant Agricultural Officer, Fort Hall.
- (s) Annual Report of the Assistant Agricultural Officer, Meru.
- (t) Annual Report of the Assistant Agricultural Officer, South Kavirondo.
- (u) Annual Report of the Agricultural Officer, Nyanza, and Native Agricultural School, Bukura.
- (v) Annual Report of the Assistant Agricultural Officer, Coast.
- (w) Summary of Meteorological Records.

Schedule showing Agricultural Exports for 1929, and previous years.

Also Charts and Photographic Illustrations indicative of the progress of agricultural industries.

ACKNOWLEDGMENTS, Etc.

In the discharge of its many functions this Department relies upon colleagues in the service and organised bodies for co-operation, and assistance. From Administrative Officers much support has been forthcoming in the development of native agriculture. To my colleagues on the Inter-Colonial Railway Council, Land Advisory Board, Kenya Advisory Council and the Council of the Royal Agricultural and Horticultural Society I desire to bear testimony to their services in the interests of agriculture. Relationship of the most cordial character continues between Associations representing industries and the various Consulting Committees with which this Department has close association. They are as follows :—

- Joint Maize and Wheat Consulting Committee.
- Stockowners Consulting Committee.
- Coffee Planters' Union.
- Coffee Consulting Committee.
- Sisal Growers' Association.
- Pig Industry Committee.
- Stud Book Committee.

Meetings of those Committees were held during the period under review and their advice and support were valuable to the Department.

Towards the end of the year proposals were discussed for the formation of two additional representative bodies, one, the Board of Agriculture, and the other an Advisory Committee on Coastal Agriculture.

Other bodies in the Colony whose representations are dealt with are the Convention of Associations and about thirty Farmers' Associations or cognate bodies.

The Department was glad to welcome members of the staff of the Eastern African Agricultural Research Institute at Amani on their visits to enquire into conditions in the Colony.

Away from Kenya, but nevertheless of interest to this Department, there has been formed the Colonial Advisory Council of Agriculture and Animal Health, and officers of this Department have been nominated to serve as correspondents on the recently formed Imperial Bureaux and correspondence centres dealing with: Animal Health, Animal Nutrition, Animal Parasitology, Animal Genetics, Bureau of Soils, Plant Genetics, Fruit Production.

These bodies cannot fail to be of great assistance to the staff in the pursuit of knowledge and working under conditions far removed from their confreres. Authorities can now be consulted, and the most recent information with regard to the problem under investigation obtained.

At the Pan-African Agricultural and Veterinary Conference held at Pretoria in August, 1929, this Department was represented by Mr. J. Walker (Chief Veterinary Research Officer), Captain E. J. Mulligan (Veterinary Officer), Mr. D. L. Blunt (Senior Agricultural Officer), and Mr. J. McDonald (Mycologist). Conferences of this kind are worthy of full support and cannot fail to be of great advantage. Not only do the officers taking part in them advance their knowledge, but the results from discussion of subjects and the contact made with fellow workers elsewhere are of great value to participating countries. Officers of this Department contributed a comprehensive selection of papers to the Conference.

The year under review has been a difficult and exacting one and heavy demands have been made upon the Department. Its efficiency has never stood higher and is steadily increasing. Its officers have worked well, having the interests of the Colony at heart, and their loyalty, to which I wish to express high appreciation, was well tested when Departmental matters fell to be considered by the Agricultural Commission.

ALEX HOLM,

Director of Agriculture.

Nairobi,

May, 1930.

APPENDIX A.

The principal changes and new appointments during the year under review were :—

1.—ADMINISTRATIVE AND GENERAL.

Mr. W. D. D. Jardine, B.Sc., (Edin.), N.D.D. (Hons.), Live Stock Officer, arrived on first appointment, 27th March.

Mr. S. Morrell, Clerk, appointed locally, 1st September.

Mr. R. B. Leach, M.C., Clerk, appointed locally, 1st November.

Mr. B. A. Pickering, Clerk, transferred from his appointment of Laboratory Assistant, Scott Agricultural Laboratories.

2.—DIVISION OF NATIVE AGRICULTURE.

Mr. W. L. Watt, Cert. H.A.S., Forestry, Assistant Agricultural Officer, promoted Agricultural Officer, 1st January.

Mr. W. G. Leckie, B.Sc., Assistant Agricultural Officer, promoted Agricultural Officer, 1st January.

Mr. R. Finch, B.A. (Dip. Agric.), Assistant Agricultural Officer, appointed 1st April.

Mr. A. B. S. Ransford, (Dip. Agric., Wye), Assistant Agricultural Officer, arrived on first appointment, 6th November.

Mr. A. C. Maher, B.A. and Dip. Agric. (Cantab.) Assoc. I.C.T.A. (Trinidad), Assistant Agricultural Officer, arrived on first appointment, 6th November.

Mr. E. W. Gaddum, B.Sc.-Agri. (Lond.), Dip. Agri. (S.E.A.C.), Assistant Agricultural Officer, arrived on first appointment, 22nd December.

Mr. G. Cottingham, Temporary Assistant Agricultural Officer, appointed locally, 27th August.

3.—SCOTT AGRICULTURAL LABORATORIES.

Mr. R. H. Le Pelley, Ph.D., D.I.C., B.Ss. (Hons.), A.R.C.Sc., F.E.S., Assistant Entomologist, arrived on first appointment, 22nd May.

Mr. S. G. Sharp, Clerk, transferred from Administration, 6th June.

Mr. B. A. Pickering, Laboratory Assistant, transferred to Administrative and General as Clerk, 1st July.

Mr. T. L. McClelland, Temporary Insectaries Manager, appointed locally, 1st July.

Mr. J. W. Phillips, Laboratory Assistant (learner grade), appointed locally, 16th August.

4.—COFFEE AND SISAL SERVICES.

Mr. M. Godley, Temporary Coffee Inspector, appointed locally, 7th January.

Mr. H. Naismith Jones, Temporary Coffee Inspector, appointed locally, 7th January.

Mr. H. L. Bolton, Temporary Coffee Inspector, appointed locally, 7th January.

Mr. H. R. H. Stone, Temporary Coffee Inspector, appointed locally, 6th August.

5.—GRADING AND INSPECTION AND COOL STORES SERVICES.

Mr. C. C. T. Sharp, Chief Grader and Inspector, resigned the Service, 22nd January.

Mr. D. F. Sargent, Foreman Mechanic, promoted Superintendent Maize Conditioning Plant and Cool Stores. 1st January.

Mr. C. L. Silvester, N.D.A., N.D.D., Assistant Grader and Inspector, promoted Acting Chief Grader and Inspector, 13th April.

Mr. O. J. Clark, Temporary Assistant Grader and Inspector, resigned 1st July.

Mr. A. D. T. Montagu, Assistant Grader and Inspector, locally appointed and transferred from appointment of Stock Inspector, 1st November.

6.—VETERINARY DIVISION.

Lt. Col. A. G. Doherty, M.C., M.R.C.V.S., Chief Veterinary Officer, proceeded on leave pending retirement owing to ill health, 20th April, and retired with effect from 22nd June.

Major H. H. Brassey-Edwards, M.R.C.V.S., Deputy Chief Veterinary Officer, assumed the duties of Acting Chief Veterinary Officer with effect from 20th April, and was promoted to the substantive post of Chief Veterinary Officer as from 22nd June.

Captain O. Dixon, M.C., M.R.C.V.S., Senior Veterinary Officer, performed the duties of Acting Deputy Chief Veterinary Officer, from 1st January to 12th April, when he proceeded on leave.

Captain J. T. C. Bradshaw, M.R.C.V.S., Senior Veterinary Officer, appointed Acting Deputy Chief Veterinary Officer, 19th April.

Mr. C. D. Cowen, Temporary Stock Inspector, appointed locally, 1st January.

Mr. G. Alcock, Stock Inspector, arrived from South Africa, on first appointment, 25th March.

Mr. C. G. Norman, Stock Inspector, arrived from South Africa, on first appointment, 25th March.

Mr. J. B. Levis, Temporary Stock Inspector, left the Service, 31st March.

Mr. C. D. Henderson, Temporary Stock Inspector, appointed locally, 16th April.

Mr. C. M. Watson, Temporary Stock Inspector, left the Service, 31st July.

Mr. G. W. Low, Temporary Stock Inspector, appointed locally, 3rd September.

Mr. A. D. T. Montagu, Stock Inspector, appointed Assistant Grader and Inspector and transferred to Maize Grading and Conditioning Services, 1st November.

7.—DIVISION OF VETERINARY RESEARCH.

Mr. J. Walker, M.R.C.V.S., Chief Veterinary Research Officer, proceeded on leave on 25th May and returned to duty 29th October. During his absence the duties of Chief Veterinary Research Officer and Assistant Chief Veterinary Research Officer were carried out by Messrs. R. Daubney, M.Sc. (Washington), M.R.C.V.S., and S. H. Whitworth, B.V.Sc. (Melb.), D.V.M. (Zur.), M.R.C.V.S., respectively.

Mr. D. Dewar, Librarian, appointed locally, 1st April.

Mr. R. S. Clark, Stockman, appointed locally, 21st May.

Messrs. W. P. Langridge and D. G. Plant admitted as Students, 13th and 18th March, respectively.

Mr. A. E. Johnstone, Clerk invalided from the Service, 31st December.

Mr. J. R. Kennedy, Clerk, services terminated 26th July.

Mr. L. O. Johns, Clerk, appointed locally, 14th November.

APPENDIX B.

STAFF LIST OF DEPARTMENT OF AGRICULTURE.

(As at 31st DECEMBER, 1929.)

Director : Alex Holm, C.B.E., F.H.A.S., M.R.A.S.E.
(Gold Med.), S.E.A.C. (Dip. Hons.).

Deputy Director : E. Harrison, M.S.A., B.Sc., N.D.A.
(Hons.), N.D.D.

ADMINISTRATIVE AND GENERAL.

Senior Agricultural Officer : D. L. Blunt, M.A.

Agricultural Officer : P. Booth, N.D.A., U.D.A.

Assistant Agricultural Officers : H. J. Taylor, S.E.A.C.
(Dip. Hons.), C. B. C. Handley, B.Sc. (Agric.) Dip. Agric.
(Wye).

Livestock Officer : W. D. D. Jardine, B.Sc. (Edin.),
N.D.D. (Hons.).

Statistical Officer : A. C. Hunter.

Accountant : H. S. Land.

Office Superintendent : E. J. Kelly.

Clerks : R. Abram, Miss M. V. Ashe, Mrs. M. A. Carr-
Hole, J. E. Harrison, Miss O. A. Kirkpatrick, R. B. Leach,
S. Morrell, J. S. Nelson, R. F. G. Palmer, F. Parker, B.
A. Pickering, J. Riddell, W. White.

Junior Clerks : A. Clough, J. B. Gould.

Clerical Learner : Miss E. M. Geater.

DIVISION OF NATIVE AGRICULTURE.

Agricultural Officers : A. G. Bailey, M.A.; W. L. Watt,
Cert. H.A.S., Forestry; W. G. Leckie, B.Sc.

Assistant Agricultural Officers : A. S. Hartley; C. G.
Bishop; C. O. Oates, N.D.A.; R. G. Bentall, B.A. (Agric.);
W. O. Sunman, B.Sc. (Agric.), Dip. Agric. (Wye); S. Gillett,
S.E.A.C. (Dip. Agric. and Vety. Sc.); R. Finch, B.A. (Dip.
Agric.); A. B. S. Ransford, Dip. Agric. (Wye); G. W. Gad-
dum, B.Sc. (Agric.), Dip. Agric. (Wye); E. Cottington,
(temporary).

SCOTT AGRICULTURAL LABORATORIES.

Senior Entomologist : T. J. Anderson, M.A., B.Sc.
(Hons. Edin.), F.Z.S., F.E.S.

Entomologists : H. C. James, Ph.D., B.Sc., N.D.A.,
N.D.D.; H. Wilkinson, A.R.C.Sc., F.E.S., F.L.S.; R. H.
Le Pelley, Ph. D., D.I.C., B.Sc. (Hons.), A.R.C.Sc., F.E.S.

Mycologist : J. McDonald, D.F.C., B.Sc. (Hons.), F.L.S.

Agricultural Chemist : V. A. Beckley, M.C., M.A., A.I.C.

Assistant Agricultural Chemist : D. S. Gracie, B.Sc. (Hons. Edin.), A.I.C.

Clerk : S. G. Sharp.

Clerical Learner : A. S. M. Gilfillan.

Insectaries Manager (temporary) : T. L. McClelland.

Laboratory Assistant : F. McNaughten, B.Sc.

Junior Laboratory Assistants : R. N. Noble, F. W. Evans, J. W. Phillips.

COFFEE AND SISAL SERVICES.

Senior Coffee Officer : A. D. Le Poer Trench.

Inspectors (temporary) : H. L. Bolton, M. Godley, H. Naismith Jones, H. R. H. Stone.

PLANT BREEDING SERVICES.

Plant Breeder : G. J. L. Burton, M.C., B.A.

Assistant Plant Breeder : R. J. Lathbury, M.A.

Assistant Agricultural Officers : N. D. Spranger, A. C. Maher, B.A. and Dip. Agric. (Cantab.), Assoc. I.C.T.A. (Trinidad).

GRADING AND INSPECTION AND COOL STORES SERVICE.

Chief Grader and Inspector : (Vacant), C. L. Silvester, N.D.A., N.D.D. (Acting).

Grader and Inspector : F. B. L. Butler, F.L.S.

Assistant Grader and Inspector : A. D. T. Montagu.

Superintendent Maize Conditioning Plant and Cool Stores : D. F. Sargent.

Clerk : L. Myers.

Mechanic : A. E. Taylor.

VETERINARY.

ADMINISTRATIVE AND EXECUTIVE DIVISION.

Chief Veterinary Officer : H. H. Brassey-Edwards, M.R.C.V.S.

Deputy Chief Veterinary Officer : Vacant.

Senior Veterinary Officers : O. Dixon, M.C., M.R.C.V.S. ; R. C. Wheeler, M.B.E., M.R.C.V.S. ; J. T. C. Bradshaw, M.R.C.V.S.

Veterinary Officers : R. Scott-Little, M.R.C.V.S., D.V.S.M.; R. L. Creery, M.R.C.V.S.; E. J. Mulligan, M.R.C.V.S.; W. J. Emerson, M.R.C.V.S.; F. R. Hale, M.R.C.V.S.; E. Beaumont, M.R.C.V.S.; W. Fotheringham, M.R.C.V.S.; W. B. C. Danks, B.Sc., M.R.C.V.S.; T. B. McClure, M.R.C.V.S.; H. Hay-Barclay, M.R.C.V.S.; D. F. Macpherson, M.R.C.V.S.; W. M. McKay, M.R.C.V.S.; F. W. Aston, M.R.C.V.S.

Stock Instructor : J. Anderson.

Stock Inspectors : D. Wyarrt; R. A. C. Campbell; W. L. Lewis; G. White; H. E. Evans; L. E. Smith; H. Thorne; T. Harris; F. T. O'Meagher; J. F. Greig; C. B. Jolley; P. H. Poolman; C. P. Glover; J. Denwett; A. Lambie; J. H. Ward; H. C. W. Guy; R. H. Cameron; F. J. O'Hara; J. P. Cassidy; H. J. Fitzgerald; A. R. Paxton; G. L. Murray; C. G. Norman; G. Alcock.

Temporary Stock Inspectors : C. D. Cowen; C. D. Henderson; G. W. Low.

DIVISION OF VETERINARY RESEARCH.

Chief Veterinary Research Officer : J. Walker, M.R.C.V.S.

Assistant Chief Veterinary Research Officer : R. Daubney, M.Sc. (Wash.), M.R.C.V.S.

Veterinary Research Officers : S. H. Whitworth, B.V.Sc. (Melb.), D.V. (Zur.), M.R.C.V.S.; R. W. M. Mettam, M.Sc., M.R.C.V.S.; J. R. Hudson, B.Sc.; M.R.C.V.S.

Laboratory Superintendent : A. Walker.

Laboratory Assistants : J. T. Schultz, H. J. Gray, J. R. McQueen, E. J. Hall, W. P. Bruce, F. Lyons, J. Forsyth, S. R. Pelling.

Overseer : J. Burton.

Yard Foreman : A. McDougall.

Clerks : A. J. Kemp, J. H. Crampton, G. M. Smith, L. O. Johns.

Clerical Learner : Miss R. M. Dennis.

Librarian : D. Dewar.

Mechanic : O. Stenmark.

Storekeeper : J. Scott.

Assistant Storekeeper : G. W. Clochley.

Stockman : R. S. Clark.

APPENDIX C.**ANNUAL REPORT OF THE CHIEF VETERINARY
OFFICER****FOR THE YEAR ENDED 31ST DECEMBER, 1929.**

GENERAL.*Settled Areas.*

The efforts of the Department during the year have been mainly confined to the control and eradication of stock diseases.

Confidence in veterinary measures has been established in the settled areas and to a certain extent in those native reserves where members of the Veterinary Staff have been stationed.

These officers have gradually inculcated in the native mind the beneficial results to be derived by the prevention of, and immunisation against various conditions which take such a heavy annual toll of domesticated stock.

The organisation of the stock industry is slowly being established in this Colony and there can be no doubt that further developments are necessary for the complete control of disease and advantages of animal husbandry.

The accepted system, of all young stock acquiring immunity to disease, requires a study of the methods of breeding, feeding and management to produce the desired results, and therefore disease control, coupled with animal husbandry, must prevail under one control.

In spite of a marked improvement in the stock industry as a whole, there are herds of stock in the settled areas which can be helped and improved by better systems of animal husbandry and management, chiefly in regard to calf rearing.

There can be no doubt that the stock industry will establish itself in this Colony because the inherent milk characteristics of the native foundation stock permit of producing a prime dairying product unequalled in the world for the quantity of butter fat.

The facts in regard to inherent milk factors are known and the control of diseases will allow stock to be kept with a high degree of safety.

There is a local market for larger quantities of animal products such as ghee, butter substitutes and tinned milk, etc., and India would, I understand, import larger quantities of ghee if this product was available in an unadulterated form.

The Customs returns for the years 1926, 1927, 1928, of imported animal products are appended for general information.

ANIMAL PRODUCTS IMPORTED INTO KENYA AND UGANDA.

	1926		1927		1928		3-years' Total	
	Cwt.	Value	Cwt.	Value	Cwt.	Value	Cwt.	Value
		£		£		£		£
Ghee	7,099	49,838	10,478	46,860	9,020	36,623	26,597	133,321
Butter	17	203	67	738	145	1,617	229	2,558
Butter Sub. ..	283	1,508	344	1,721	524	2,601	1,151	5,830
Lard	98	630	102	656	143	893	343	2,179
Tinned Milk ..	8,931	32,537	9,309	30,303	11,998	38,353	30,238	101,193
Bacon and Ham	122	1,316	122	1,237	99	901	343	3,454
Cheese.. ..	118	1,411	161	1,783	269	3,031	548	6,225
Tinned Meat..	910	5,311	3,286	11,977	1,445	6,950	5,641	24,238
TOTALS ..	17,578	92,754	23,869	915,275	23,643	90,969	65,090	278,998

Many pure bred bulls and rams of various breeds have been recently imported with the aid of grants from the Empire Marketing Board and these animals must improve the herds and flocks of the Colony.

There are great areas of land in the occupation of farmers which are given over to the cattle of their squatter labour. Most of this land should be running dairy herds to provide fertilisers for crops as well as affording a further source of income to the farmer from dairy products.

The valuable land being used by unproductive native stock, if taken into account on a money basis, makes the cost of labour rather high.

The Fencing and Cattle Cleansing Bills have become law during the year, and as there is a necessity for closer supervision of stock on all farms the introduction of these Bills will assist in this direction.

It is gratifying to report that the fencing of holdings and the dipping of stock are developing on an increasing scale, and this is sure to have a beneficial effect on the incidence of disease.

The welfare of the stock industry in the settled areas greatly depends on the elimination of native-owned stock from the farms, and it is a pleasure to record that in some of the

chief stock raising districts, this undesirable stock has been completely or partly eliminated. It is hoped that general results of a similar nature will be forthcoming with the introduction of the Fencing of Holdings Ordinance.

It is estimated that over two hundred thousand native cattle and nearly half-a-million native sheep and goats are grazed on alienated land.

During the year a surplus of slaughter live stock has been reported from the stock farmers in the settled areas, and in spite of increased demands for which a local market cannot be found. Many dairy farmers are killing off the bull calves for the same reason.

In past years Government has repeatedly been approached by the butchers, with requests for assistance in finding sufficient slaughter bullocks to meet local requirements; so it would appear that progress can be reported and the experiences of the past years are the factors which cause and will maintain a slow and steady encouragement in the production of good livestock.

In the sheep industry there is a vast field for improvement and expansion, as there are large tracts of the country that are suited for sheep breeding. Up to the present, however, various sheep diseases take a heavy annual toll of the flocks.

The European farmers are concerned principally with woolled types, as the local wool finds a ready market in England.

Most native reserves are quite unsuitable for the rearing of wool sheep, but the improvement of native sheep can be easily instituted by the crossing of selected ewes with good types of local or imported rams of a mutton breed.

The pig industry is well established and with the facilities offered by the food crops, which can be easily grown in the Colony, it does form a useful adjunct to farming operations, especially when exploited in conjunction with dairying.

It is to be noted that in this Colony pigs have so far not been affected with tuberculosis and cases of measles are very rare indeed.

The two major diseases affecting pigs are Anthrax and Swine Fever.

Report of outbreaks of animal diseases, settled areas, for the past four years.

DISEASES	Number of Outbreaks during			
	1926	1927	1928	1929
Rinderpest	71	73	83	66
East Coast Fever (Clean Areas) ..	58	31	37	32
Pleuro Pneumonia	11	20	8	4
Blackquarter	11	22	18	13
Trypanosomiasis	6	11	6	9
Foot and Mouth Disease ..	9	22	7	7
Sheep Pox	1	2	..	3
Horse Sickness	13	8	18	11
Ulcerative Lymphangitis	38	42	27	23
Epizootic Lymphangitis	17	7	7	3
Swine Fever	3	2	7	—
Contagious Bovine Abortion ..	2	1	9	5
Anthrax	7	27	43	20

In addition the following outbreaks of disease occurred in 1929 :—

Anaplasmosis 14	Bovine Lymphangitis .. 3
Blue Tongue 2	Laikipia Lung Disease .. 1
Actinomycosis 1	Tuberculosis 2
Heartwater 4	Rabies 1

In connection with the detailed statement of outbreaks of animal diseases in settled areas, it has to be recorded that for the first time cases of Rabies, in dogs; Actinomycosis and Milk Fever in cattle; and Pulpy Kidney in sheep, have been reported and confirmed.

The present veterinary districts are very large and, in spite of the assistance given for rinderpest inoculation by a special service, the staff are unable to cope with all the demands for assistance.

Taking the Colony as a whole, the diseases which demand the greater portion of the departmental energies are Rinderpest, Contagious Bovine Pleuro-pneumonia, tick-borne diseases, sheep diseases and, to a lesser extent, Contagious Abortion, Trypanosomiasis, Anthrax, Blackquarter and Plant Poisons.

Rinderpest.

The year 1929 is the best on record in regard to the number of outbreaks of Rinderpest in settled areas. There is need to continue with protective measures as the incidence of this disease is still heavy, resulting from the uncontrolled movement of native-owned squatter stock.

Sixty-six outbreaks have been reported and confirmed during the year, as compared with eighty-three in 1928, seventy-three in 1927, and seventy-one in 1926.

Unfortunately one big wave of Rinderpest, involving the Machakos and Nairobi districts, accounted for fifty-six outbreaks amongst squatter stock, otherwise the annual record of outbreaks in stock-owning districts would have been extremely small. The details of the outbreaks are given under the heading of the different veterinary districts.

RINDERPEST SERVICE.

This service was fully occupied during the year as the appended statistics will show, in addition to which the service has assisted in district inoculations.

The mortality returns show that the percentage of losses in dipped stock inoculated were approximately 1.5 per cent, whilst that in undipped and native stock was less than 1 per cent.

These figures compare favourably with the percentage of mortality recorded in 1928, viz. 1.6 per cent.

As in former years, the chief cause of mortality was Redwater; deaths from Rinderpest were practically nil.

The difficulties of the control of Rinderpest produced by inoculation which were experienced in the early days of double inoculation, would appear to have been overcome in recent years, as no serious mortality has resulted from severe reactions in this disease. The latter aspect of double inoculation has been rendered negligible by the administration of larger doses of anti-rinderpest serum.

The danger of the simultaneous transmission of Redwater and Rinderpest virus, which has been responsible for high mortality in "dipped stock," has been largely overcome by the use of tested virus-makers, free from Redwater, supplied by the Laboratory. This method has been in use during the year under review.

Results have, for the most part, been satisfactory and experience shows that this method has distinct advantages over other methods.

Temporary set-backs have, however, been encountered and several virus makers, proving immune to Rinderpest, failed to react, in two instances the "clean" virus makers in all probability transmitted Redwater with resultant high mortality.

The former difficulty might be overcome by rearing susceptible animals.

In regard to the latter, observations pointed to the fact that the virus maker was infected with Redwater, through the medium of the virulent nasal discharge, at the time of infection with Rinderpest.

The recent improvement in the technique of the method of infecting these "clean" animals by the injection of treated virulent spleen pulp would appear to have overcome the latter difficulty, no mishaps having been encountered since its introduction.

To sum up it might be said that the experiences of 1929, as outlined above, in the immunisation of farm stock, show that with the elimination of the above-mentioned difficulties in the manner indicated, the method, in addition to greatly minimising the risks of double inoculation, will have gone far towards the solution of the economical and financial problems arising in the carrying out of the Rinderpest work by a specialised staff.

Comparison of the figures shown with those of the previous year will indicate a considerable decrease in the number of animals treated. This decrease is explained by the fact that farm-to-farm inoculations comprised the main work of the service during 1929, European owned stock being almost invariably dealt with, whereas in the previous year a considerable amount of central crush work was accomplished in the Trans Nzoia district, where large numbers of native-owned stock were presented for treatment under compulsion.

Farm-to-farm inoculations must always be slower, and smaller numbers of animals of necessity dealt with.

Comparison of the figures for 1929 with those for 1927 illustrates this point. Here the figures closely approximate and inoculations carried out in 1927 were for the most part farm to farm.

The demands for the service of the Rinderpest staff this year were great, necessitating the division of the service into two separate units, each functioning in a different veterinary district.

By this means it was found possible to cope with practically all demands for double inoculation made by the Farmers' Associations throughout the country.

In this connection it is worthy of note that during the year the Trans Nzoia District Committee again requested that double inoculations of all susceptible stock in the district be made compulsory in 1930. The Uasin Gishu District Committee made a similar request and there are signs in other districts that such a course will be adopted in the near future.

The attention of the public might be drawn to the matter of cattle crushes.

The majority of crushes in the settled areas, built in a time of stress when cattle were suffering from Rinderpest naturally contracted, and inoculations had perforce to be carried out hurriedly, are found to be entirely unsuited to present day needs.

Such crushes were built to accommodate mature animals, and they have been found to be almost useless in districts where double inoculations have been carried out annually and the animals presented for treatment were of the young weaner type.

It will be seen, therefore, that the work is undertaken in many instances with the greatest of difficulty and not without danger both to the stock and to the staff conducting the operations.

Such a state of affairs should be remedied. It is suggested that the matter be brought to the notice of farmers, through the medium of District Associations, and approved diagrams of crushes distributed.

Erection of crushes of approved dimensions will enable officers to carry out inoculations efficiently and grave personal injury to personnel and stock will thus be avoided.

ANALYSIS OF INOCULATIONS AND VACCINATIONS CARRIED OUT BY THE VETERINARY FIELD STAFF, 1929

STATION	RINDERPEST DOUBLE INOCULATIONS						Rinderpest Virulent Blood Tests	Anti-Rinder- pest Serum + Alone Inoculation	Pleuro-pneu- monia Vaccin- ation	East Coast Fever Tests	Mallein Tests	Mortality, All Causes Approximate	Tuberculosis Tests
	Adults			Weaners and Calves									
	Native	Farm	Trade	Native	Farm	Trade							
Nairobi	2,631	10,019	1,667	233	1,496	298	33	355	..	..	..	228	76
Gilgil	..	744	..	..	37	..	..	..	1,312	..	..	24	..
Lumbwa	1,035	15,832	..	1,043	4,796	..	45	..	..	..	..	564	..
Rinderpest Service ..	..	22,706	..	..	13,350	..	1,416	..	..	..	2	478	..
Nanyuki	..	610	..	..	353	..	..	..	6,071	..	..	15	..
Machakos Settled Area ..	7,015	683	..	402	117	..	..	..	..	..	..	225	348
Machakos Quarantine Stn.	786	749	946	73	57	7	..	..	..	..	..	65	..
Alego	3,488	..	..	1,928	..	..	..	..	..	..	..	125	..
Samia	7,832	..	..	2,304	..	..	..	..	..	..	..	294	..
Maseno	5,284	..	..	6,716	..	..	..	..	..	..	..	437	..
Timboroa Njemps ..	4,256	..	..	3,378	..	..	6,749	..	2,100	..	..	69	..
Kingwal	4,578	..	228	248	..	..	886	..	49	..	..	195	..
Kitai	6,344	..	..	1,464	..	..	..	..	..	..	..	311	..
Kibigori	8,837	303	..	3,292	191	..	43	..	1,173	318	98	..	..
Isiolo	..	..	..	..	..	..	..	46	1,915	401	..	39	..
Waterfalls	784	..	..	..	..	..	1	..	..	..	..	..	..
Kaptumo	938	..	85	234	..	..	..	..	57	..	..	..	..
TOTAL	53,808	51,646	2,926	21,315	20,397	305	9,173	401	12,677	719	100	3,177	424

SUMMARY OF RINDERPEST INOCULATIONS.

DOUBLE INOCULATION—

Adult—Native ..	..	..	..	53,808
Farm ..	..	..	..	51,646
Trade ..	..	..	..	2,926
Calves—Native ..	..	..	..	21,315
Farm ..	..	..	..	20,397
Trade ..	..	..	..	305
VIRULENT BLOOD TESTS ALL STOCK ..	..	..	..	9,173
SERUM ALONE INOCULATIONS ..	..	..	..	401
				159,971

The following table indicates the work carried out by this service during the year.

DISTRICT	Double Inoculations	Virulent Blood Tests	Mortality Approximate
Nanyuki	18,901	5	283
Gilgil	4,868	.. ..	72
Uasin Gishu	12,287	1,411	123
TOTAL	36,056	1,416	478

The above figures for double inoculations include 22,706 adults and 13,350 calves.

In addition to the above certain herds in the Elmenteita area, previously double inoculated, were tested for immunity.

The appended tables show the total Rinderpest inoculations in all areas during the year.

RINDERPEST INOCULATIONS.

AREA	Double Inoculations	Virulent Blood Tests	Serum Alone Inoculations
SETTLED AREAS. (a) <i>By District Staff.</i>			
Nairobi	16,344	33	355
Gilgil	781	..	..
Lumbwa	22,706	45	..
Nanyuki	963	..	..
Machakos	8,217	..	..
	49,011	78	355
(b) <i>By Rinderpest Services in Settled Areas.</i>			
Uasin Gishu and Trans Nzoia	12,287	1,411	..
Nanyuki	18,901	5	..
Gilgil	4,868	..	..
	36,056	1,416	..

RINDERPEST INOCULATIONS—(Contd.)

AREA	Double Inoculations	Virulent Blood Tests	Serum Alone Inoculations
IN NATIVE RESERVES AND AT VETERINARY QUARANTINE STATIONS.			
Machakos Quarantine Station	2,618	..	..
Alego	5,416	..	..
Samia	10,136	..	..
Maseno	12,000	..	..
Timboroa and Njemps ..	7,634	6,749	..
Kingwal	5,054	886	..
Kitai	7,808	..	..
Kibigori	12,623	43	..
Waterfalls Quarantine Station	784	1	46
Kaptumo	1,257	..	..
	65,330	7,679	46
TOTALS.			
In Settled Areas by District Staff	49,011	78	355
In Settled Areas by Rinderpest Service	36,056	1,416	..
In Native Reserves and Qua- rantine Stations	65,330	7,679	46
	150,397	9,173	401

The total mortality from all cases was approximately 3,177.

The total figures for rinderpest inoculations for the year 1928 are appended for purposes of comparison.

	Double Inocula- tions	Virulent Blood Tests	Serum Alone Inocu'ns.	Mortality Approx- imate
In Settled Areas by Dis- trict Staff	14,548	..	..	..
In Settled Areas by Rin- derpest Services ..	82,637	15,246	..	..
In Native Reserves and Quarantine Stations	59,296	10,757	73	..
TOTAL	156,481	26,003	73	3,170

Rinderpest Vaccination.

Work on Rinderpest vaccination was in the experimental stage at the beginning of the year and sufficient progress has been made to allow of a field experimental vaccination with an inactivated type, on a limited number of cattle, being carried out.

Several thousand cattle were vaccinated with two types of inactivated vaccines free of charge, without any untoward results.

All types of cattle were vaccinated in different parts of the Colony without reactions.

At a later date these cattle will be tested at different intervals on their immunity, by contact, exposure, and by inoculation with virulent blood.

Such tests will help the Department to decide as to whether Rinderpest vaccination is likely to be of general value to the Colony.

Contagious Bovine Pleuro-pneumonia.

During the year the incidence of this disease in the settled areas was confined to one district, Eldoret, where two outbreaks were reported on farms bordering the infected Rift Valley Native Reserves, and must be considered an extension of infection therefrom.

However, the disease is still prevalent in native reserves and infection is active among the Samburu native stock in the Northern Frontier Province, the East Suk cattle in the Rift Valley Province, the Lumbwa cattle in the Nyanza Province, and in the Kaputei Masai cattle.

Other native areas, as the result of general vaccinations, are reported to be free from the disease.

The following figures are appended for comparison, recording the number of outbreaks of Bovine Pleuro-pneumonia for the past four years.

1926	1927	1928	1929
11	20	8	4

It is hoped that the settler community will take advantage of the free issue of Pleuro-pneumonia vaccine and immunise their cattle annually, for although the infection is small at present in the settled areas, there is evidence of heavy infection in the adjoining native reserves which can be guarded against by methods of protective vaccinations.

Tick Borne Diseases.

The passing of the Cattle Cleansing and Fencing of Holdings Bills, is a step in the progress of the pastoral industry of the Colony which has been too long delayed. Their effective application must check the progress of tick borne diseases.

The provisions of the Cattle Cleansing Bill were originally drafted to bring about the compulsory cleansing and dipping of cattle throughout the settled areas, but as the result of representations from stock owners, the powers of the Bills were altered and the actual compulsory elimination of ticks generally, now represents only an attempt to eradicate the East Coast Fever infected tick in certain areas. The application otherwise is dependent on local option.

Although the present Bill does not give the full scope desired by the Veterinary Department, the latter is prepared to accept the principle of a Bill which allows the compulsory cleansing of cattle to become law, as it is thought as the benefits of dipping, with fencing, become recognised, a compulsory system of wider application would be ultimately adopted in the Colony.

The stockowners of the Colony have made clear by resolutions passed through their District Associations their alarm at the rapid spread of East Coast Fever, and have expressed doubts in regard to the present methods of control.

There is no doubt but that the position in regard to tick-borne diseases is menacing.

Any system of control, with the aim of ultimate eradication of tick borne diseases, must be based on the prevention of its spread and the best system known to veterinary science is a combination of compulsory cleansing of stock and the fencing of holdings.

The problem of eradication of tick borne disease in this Colony is made a difficult one because public opinion is divided on the question. It is stated by one school that ticks should not be eradicated but perpetuated as it is desired that the young stock may contract such diseases and be rendered immune. In other words, all the Colony should be allowed to become infected for the sake of producing immune herds. Such a policy is not in the interests of a progressive Colony and seems to be one of despair. The loss of life from tick borne diseases makes such views an admittance of failure.

The introduction of the Cattle Cleansing and Fencing Bills has given the lead as to the correct policy to be followed, as with the gradual co-option of districts for preventative measures of eradication, the mass of public opinion will follow and demand a general compulsory supervision as practised in the Union of South Africa and Southern Rhodesia with success. The cleansing of cattle in this latter Colony has been

successful, and infection has been reduced to a few outbreaks; a slaughter policy has now been adopted for economical reasons to clear up the remaining infected areas.

East Coast Fever.

The number of outbreaks reported and confirmed in clean areas during the year 1929 was thirty-two.

The following table indicates the number of fresh outbreaks in "clean" areas during the past four years.

AREA	1926	1927	1928	1929
Northern Clean Area ..	47	37	38	26
Molo Clean Area ..	8	3	12	6
Limuru Clean Area ..	2	4	1	..
TOTAL ..	57	44	51	32

The following table shows the number of quarantines for East Coast Fever which were revoked during the past four years.

AREA	1926	1927	1928	1929
Northern Clean Area ..	4	18	32	27
Molo Clean Area ..	4	7	3	3
Limuru Clean Area ..	..	1	1	2
TOTAL ..	8	26	36	32

RETURNS FROM GOVERNMENT DIPPING STATIONS FOR THE YEARS 1926, 1927 AND 1928.

STATIONS	EQUINES			CATTLE			SHEEP AND GOATS		
	1927	1928	1929	1927	1928	1929	1927	1928	1929
Nakuru ..	15	36	..	7,941	6,974	13,404	19,538	15,442	26,997
Gilgil	147	2	1	9,590	9,048	9,765	..	..	..
Isiolo	..	121	98	280	921	..	21,700	80,015	55,515
Nanyuki ..	..	..	2	13,977	19,278	25,947	..	..	..
Rumuruti ..	..	..	..	..	1,400	3,115	..	..	..
Eldoret	..	..	21	..	..	771	..	706	..
TOTALS ..	162	159	122	31,788	37,621	53,002	41,238	96,163	82,512

During the year East Coast Fever spread seriously in the gazetted "clean areas" particularly those of Laikipia, Nanyuki and Naivasha.

Of the twenty-six outbreaks confirmed in the Northern Clean Area, nine were reported from Laikipia, nine from Naivasha and eight from Nanyuki. There were six outbreaks in the Molo Clean Area and none in the Limoru Clean Area. The Laikipia and the Naivasha outbreaks have been successfully handled by strict supervision by experienced dipping inspectors, and as most of the infections were light in the first instance, very considerable progress in the cleaning up of these areas is reported by the District Veterinary Officers.

Heartwater.

A considerable increase in the incidence of this tick borne disease is reported, the causal tick being spread by the trekking sheep of the itinerant trader; sheep from the Northern Frontier Districts appear to be immune from the disease.

The diagnosis of Heartwater is difficult, inasmuch as material for investigation must be collected during a certain phase in the course of the disease to make diagnosis a certainty, and owners, as a rule, are not disposed to sacrifice an animal in order to collect suitable material.

Accordingly the percentage of mortality from Heartwater in stock born and reared on infected farms has not been worked out.

There can be no doubt that the disease is widespread in the Colony as the hosts of the "Bont" tick include all domestic stock, game and vermin and since an infected nymph tick does not necessarily clean itself by feeding on non-susceptible animals including game, the difficulty of eliminating Heartwater-infected ticks is greater than is the case with East Coast Fever-infected ticks.

Farmers have had considerable success in eradicating the adult "Bont" tick by dipping at seven days' interval in a fourteen days' dip fluid strength and by passing their flocks of sheep through a hip dip to permit of this short interval dipping in woolled sheep.

Redwater and Anaplasmosis.

These may be said to be prevalent on most farms and to be responsible for a big annual mortality in young stock.

On farms where dipping and hand dressing of cattle is practised carefully, clean and susceptible calves are reared with slight loss.

Piroplasmosis affecting dogs and horses is reported from most areas but can be treated with success by the well-known medical remedies.

SCHEME FOR ASSISTED IMPORTATION OF PEDIGREE LIVESTOCK
FROM THE UNITED KINGDOM.

Under section 7 of the above scheme the Chief Veterinary Officer holds discretionary powers as to whether imported cattle should go through the Veterinary Quarantine Station, for purposes of immunisation against Redwater and *Anaplasmosis*, or should be allowed to proceed direct to the farm and be treated there.

Many applications have been received in the past for animals to be taken direct to the farm. These applications have received favourable consideration whenever the owner was able to supply a reasonable guarantee that the cattle would be suitably housed and transported from the station to the farm; kept tick-free during the process of immunisation, and agreed to follow instructions, issued from time to time by the Laboratory, whilst the animals were under treatment.

Nowhere else in the world is the immunisation of cattle against Redwater and *Anaplasmosis* more advanced than in Kenya Colony. The treatment attains a large degree of finality in that the animals are first prepared by the inoculation of a mild strain of *Anaplasmosis* and their resistance is subsequently reinforced by inoculation with a vaccine, containing natural and stronger strains of Redwater and *Anaplasmosis*, and comparable with the strains transmitted by ticks on the farm.

Other countries are satisfied with the first step of the immunising process, and virulent strains of the infection are not used.

It must be realised that Redwater and *Anaplasmosis* immunisation is a complicated procedure, and time must be taken to establish immunity with the minimum amount of risk.

It is considered that any attempt to curtail the present method would be attended by increased losses.

The period of detention at the Quarantine Station entirely depends on the resistance of each individual and the time taken over each reaction, which in certain cases is very prolonged. Then again, some animals will fail to react to Redwater from the inoculation of the blood vaccine which produces the desired results in other animals treated with the

same virus, at the same time. In cases of this nature an increased delay occurs, as the beast must be re-inoculated with the second vaccine after the marginale reaction has subsided.

The long period of detention, with the attendant cost, has been the cause of adverse criticism from various owners, and the result is that many farmers have applied to have their animals treated on the farm. In this connexion, however, it should be noted that the actual cost of the care and feeding of the animals whilst at the station is well above the charges made, and only covers the cost of food and attendance. It is advised that bulls should be imported into the Colony between the ages of twelve and fifteen months as the detention in the quarantine station of about six months, for the purpose of immunisation, gives the animals an opportunity of becoming acclimatised during their detention, and on discharge they are able to commence service on arrival at the farm.

During the year 1929 eighty-three pedigree cattle were treated at the Nairobi Veterinary Station.

Of these, forty-six beasts were actually admitted during the year, whilst the balance is made up of animals which were admitted at the station in November, 1928.

The cause of death in three cases was due to Anaplasmosis transmitted by vaccination. Two out of the three deaths, however, occurred in heifers which eventually proved to be pregnant, and the treatment of such animals is not usually recommended.

In four cases the deaths were due to a peculiar haemorrhagic condition which proved fatal to animals affected.

A great deal of work has been carried out in the investigation of this disease, but in spite of all our endeavours to arrive at a diagnosis, nothing specific has as yet been discovered, and the determination of the disease or its cause still remains obscure.

A very full report has been submitted by the Laboratory on all the work carried out in connexion with this disease, and is published in the Annual Report of the Agricultural Department, 1929.

Two of the other deaths which occurred at the station were due to accidental causes.

Subsequent to release from the quarantine station, after vaccination, three animals were reported as having died from Redwater and Anaplasmosis, or both, as a result of tick infection on the farm.

The presence of Redwater and Anaplasmosis parasites in blood smears from those bulls was confirmed by the Laboratory in one instance. In this connexion it must be remembered that an animal recently recovered from Redwater and Anaplasmosis, will break down to those infections, especially the former, under the influence of some concurrent disease or of adverse climatic or other conditions.

It must be realised therefore that in recently vaccinated animals the presence of those parasites in smears made from the blood of such an animal should not be attributed to re-infection with Redwater and Anaplasmosis, as primary causes of the beast's sickness, or even death, soon after release.

In view of the complicated nature of vaccination against Redwater and Anaplasmosis and the attendant risks of such treatment being carried out on farms, where prolonged veterinary observation is impossible, it may be necessary to bring under review the discretionary power of the Chief Veterinary Officer under section 7 of the scheme for assisted importation of pedigree cattle.

In the meantime the object of this note is to review the position in the light of experience gained, and give the farmers the fullest information.

Anthrax.

It is well known that Anthrax has been a scourge in the Colony for many years, as in other parts of Africa.

There can be no doubt that the number of outbreaks reported and diagnosed form only a small portion of those outbreaks occurring in the Colony, particularly in native reserves.

Owing to the large number of outbreaks which remain undiagnosed, with the resultant careless handling of carcasses there is no doubt that there is a serious increase in the contamination of the land.

There is a great deal of confusion in regard to the diagnosis of the disease, many subacute or even acute cases of Anthrax being considered as snake bites, because in both conditions there is frequently an oedematous swelling over some part of the body and these swellings are indistinguishable in appearance.

The trade in hides and skins constitutes an important factor in the spread of anthrax.

Under the present regulations Anthrax is a notifiable disease and as in most cases diagnosis is established after the disposal of the carcass by burning, or at the expense of native life, official action is only taken when an outbreak occurs in a dairy herd when the medical authorities are informed of the outbreak.

From a veterinary point of view the present position is most unsatisfactory because it is realised how impossible it would be to enforce stringent veterinary measures throughout the Colony, owing to the scattered population, to the wide-spread distribution of Anthrax, and the ideal conditions for the growth of the causal organism.

It is evident that not enough use is made of the Anthrax vaccine prepared and issued by the Veterinary Laboratory, Kabete, and which has proved efficacious in giving an immunity for the period of about a year.

The control of Anthrax is one of the problems to be solved and already the consulting committee representing the stockowners of the Colony have received a considered opinion on the measures necessary to enforce restrictions and prevent the dangers of a further spread of Anthrax.

Outbreaks of Anthrax have been reported in pigs as a result of eating the meat of **Anthrax carcasses**.

The following is a record of reported outbreaks of Anthrax :—

1926	7 outbreaks
1927	27 „
1928	43 „
1929	20 „
Total for four years	97 „

8,863 doses of Anthrax double vaccine were issued by the Laboratory during the year 1929, as compared with 16,000 in 1928, 14,000 in 1927, and 15,800 in 1926.

Trypanosomiasis.

Outbreaks of Trypanosomiasis occurred in several districts, affecting transport and plough bullocks on certain estates.

In spite of a vigorous search no evidence of tsetse fly could be found in the districts.

There is a history of the possibility of some of the oxen having come from native reserves where tsetse fly and Trypanosomiasis exist and the prevalence of blood-sucking flies on the infected farms.

Following on the success reported by Hornby and Bevan, a series of treatments have been attempted on heavily infected cattle both in the settled areas and native reserves.

The results of the experimental injections of Antimosan and antimony tartrate solution have proved successful and the results of the operations indicate that the experiments may be more generally applied.

Rabies.

In view of the deep general interest taken in this disease, chiefly owing to its transmissability to man, and man's greatest companion, the dog, and to the most awful results consequent on infection of man or beast, I wish to place on record the first case of Rabies which has definitely been diagnosed through bacteriological means in Kenya. In this connection I propose to give a résumé of previous cases reported but not confirmed.

History of unconfirmed cases.—In pre-war days it was suspected that a form of Rabies existed in this country, and reports of cases were received from various parts of the Colony, but these were never confirmed, and man was never known to have been infected.

It has recently been stated by an officer of long experience and with a vast knowledge of the country, that Rabies has been more or less enzootic in the Northern Frontier Province since 1912, and that Administrative Officers have frequently recorded cases of "mad dogs" in various parts of the Province, the usual procedure adopted in such cases being the destruction of all dogs in the vicinity.

Arising out of the above statement it is interesting to note that a case of Rabies in a lioness imported from Abyssinia to Paris is recorded in the "Annales de L'institut Pasteur" of December, 1922, and in the "Veterinary Tropical Bulletin," Volume II of 1923.

This case occurred in one of four eight-months-old lionesses imported from Abyssinia.

On the day of arrival in Paris one of the lionesses was found to behave strangely, it appeared depressed and remained apart from the others, and there was a complete loss of appetite. On the following day the animal was restless and roared continuously and it was noted that the voice had a deeper tone. Twenty-four hours later paralysis of the hind quarters set in. This extended rapidly and within twenty-four hours the fore legs were involved. Death took place on the third day.

On microscopical examination of sections of the brain, bodies diagnostic of rabies and called "Negri bodies" were found; characteristic lesions were also present in the nervous system.

The inoculation of a brain emulsion from this case into small laboratory animals produced typical Rabies in fourteen to fifteen days. The infection in this case almost certainly took place in a country bordering on our Northern Frontier Province.

A case of Hydrophobia was reported in the Kenya and East African Medical Journal of February, 1928.

In June, 1928, a case of suspected Rabies occurred in a dog in the Nanyuki district, but this case could not be confirmed with any degree of certainty as the specimens submitted for diagnosis were damaged and were unfit for accurate diagnosis.

In August, 1928, three cases of suspected Rabies were reported from Wajir in the Northern Frontier Province, but as no specimens were submitted for diagnosis, this outbreak also remains unconfirmed.

It is believed that two native women were bitten by one of the suspected animals during this outbreak, but no information is available concerning their subsequent fate.

History of the Confirmed Case.—In June, 1929 a military officer arrived in Nairobi from the Northern Frontier Province and brought with him a piece of brain from a dog which was suspected of being affected with Hydrophobia.

This specimen was submitted to the Veterinary Laboratory for diagnosis and a rabid infection was demonstrated by microscopical examination of sections.

The history of this case is as follows.

A dog belonging to one of the officers stationed at Wajir showed suspicious symptoms, bit another officer, a K. A. R. Corporal, and a *mtoto*, and licked various other persons. This animal also came in contact with other dogs in the Boma. The dog was destroyed and the brain submitted for examination, with the result stated above.

The human beings who were either bitten or licked by the infected dog were sent to Nairobi for treatment.

All dogs at the station which might have been infected by the rabid dog were destroyed, with the exception of three which were sent to the Veterinary Laboratory, Kabete, for observation.

Those animals did not develop Rabies and have since been released. Since the above case the following report has been received from the Acting Provincial Commissioner, Northern Frontier Province.

“ Rabies has broken out again and this time in the Marsabit District. In this instance a Boran was bitten by a dog four months ago and later went mad. Whilst being controlled he bit another man. The first person has died but there is no news at the moment of the man who was bitten by the deceased.”

As soon as a positive diagnosis was made in June, 1929, the Veterinary Officer, Nanyuki, was instructed to visit the Northern Frontier to investigate the whole position, especially in connection with the possible source of infection in this case, and the extent to which the disease may have spread. This officer reports that the source of infection could not be traced, and that no other suspected cases came under notice.

The Game Department was also asked for assistance, with a view of finding out if the disease could be traced amongst the wild carnivora which abound in the Wajir area. The Acting Game Warden very kindly instructed the Assistant Game Warden of the District to undertake the necessary investigations.

This officer made an extensive tour of the Northern Frontier Province embracing the Wajir and Moyale District, some jackals and hyenas were trapped and the brains submitted to Kabete for examination, with negative results. The Assistant Game Warden reports that during the whole of his *safari* he did not see any animal which looked as though it was suffering from Rabies. Although it was reported to him

that two days before his arrival at Wajir, a hyena got into the Syces' lines through a barbed wire fence and could not get out again, was killed by the Syces, and the carcase thrown away. The Assistant Game Warden comments on this case as follows :—

“ Undoubtedly it is possible that this animal was a sick one—as normally they are far too cunning to advance inside barbed wire fencing.”

Veterinary Measures taken.—All neighbouring countries and others interested were warned of this case of Rabies by cable, so as to enable the authorities to take whatever protective measures they considered necessary in connexion with importation of canines and felines from Kenya.

Public Notices were published in the Official Gazette and similar notices were forwarded to the local press.

The Northern Frontier Province was immediately placed in quarantine, no movement of dogs being allowed in or out of the Province.

As previously stated all dogs in the Wajir area were destroyed except three animals which were sent to the Laboratory for observation

A public notice was posted in a prominent place in Wajir notifying all concerned that any uncontrolled dog found without a muzzle would be shot at sight.

In cases of Rabies or suspected Rabies directions have been issued, with slight variations, to Government Departments concerned, but may prove of some assistance to private individuals, when an officer is not available.

Paturient Paresis (Milk Fever).

Up-to-date Milk Fever was believed to be non-existent in Kenya. Cases, if they did occur, have been so uncommon that they have passed unnoticed, or this condition may have been mistaken for some of the numerous obscure ailments affecting cattle in the Colony. Confusion may frequently arise, especially in connection with certain cases of vegetable poisoning which cause symptoms very similar to Milk Fever.

One authentic case of Milk Fever has been recorded in the Colony.

It was to be expected, however, that with the development of the dairy industry, the grading of the foundation herds of native stock, and the intensified methods of feeding, with a view to increased milk production, cases of Milk Fever would be recorded.

It is to the advantage of stock owners, however, that the open air conditions of cattle life prevailing in the majority of herds, and the exercise to which animals are subjected during the process of grazing are not conducive to the development of Milk Fever, and it is anticipated that as long as these conditions exist, cases of Milk Fever will still remain infrequent.

NAIROBI VETERINARY DISTRICT.

This includes the following districts: Limuru, Kiambu, Ruiru, Thika and Makuyu settled Administrative Districts and the Southern Kikuyu Native Reserve, all of which are endemic East Coast Fever Areas, with the exception of a comparatively small area known as the Limuru Clean Area.

Summary of outbreaks of disease in the Nairobi District during the years 1927, 1928, 1929 :—

DISEASE	Number of Outbreaks during		
	1927	1928	1929
Rinderpest	7	5	45
East Coast Fever (Limuru Clean Area)	4	1	..
Horse Sickness	..	11	2
Ulcerative Lymphangitis	8	8	9
Epizootic Lymphangitis	..	4	1
Anthrax	7	9	8
Swine Fever	1	..	..

Rinderpest.—Forty-five outbreaks of this disease were reported during the year. In the areas of Thika, Makuyu and Punda Milia, inoculations were made compulsory. There is no doubt that most of these outbreaks were due to the illicit movement of cattle.

East Coast Fever.—There were no outbreaks in the clean area, and two farms were removed from quarantine.

Horse Sickness.—Two outbreaks were recorded during the year.

Anthrax.—Eight outbreaks occurred during the year and 248 animals were vaccinated by the district staff.

Tuberculosis.—One case was diagnosed; seventy-five animals were tested by tuberculin but no further reactors were found.

SLAUGHTER STOCK—NAIROBI.

The following table indicates the numbers of stock slaughtered at the Nairobi Abattoir during the years 1927, 1928 and 1929.

	1927	1928	1929
Cattle	10,811	12,107	12,154
Sheep and Goats	23,683	27,610	25,657
Pigs	929	1,139	1,412

Of the above animals the undermentioned numbers of carcasses were condemned as unfit for human consumption :—

	Number of condemned carcasses	Total weight of meat condemned
Cattle	1,075	<i>lb.</i> 375,864
Sheep and Goats	301	9,210
Pigs	7	695

NANYUKI VETERINARY DISTRICT.

This area includes the North and South Nyeri and Laikipia Districts, and the adjoining native reserves in the Kenya and Northern Frontier Provinces.

Summary of outbreaks of diseases during the years 1927, 1928 and 1929 :—

DISEASE	1927	1928	1929
Rinderpest	28	4	4
East Coast Fever	21	4	17
Blackquarter	11	8	3
Bovine Pleuro-pneumonia	3	2	2
Anthrax	4	3	2
Foot and Mouth Disease	5	3	..
Sheep Pox	1	..	..
Horse Sickness	6	3	4
Ulcerative Lymphangitis	4	4	2
Epizootic Lymphangitis	2	2	..
Canine Piroplasmosis	12	11	..

In addition, in 1929, the following outbreaks occurred :—
Heartwater, 1; Anaplasmosis, 1; Rabies, 1; Trypanosomiasis, 1.

The outstanding features of the year with regard to disease have been :—

- (a) The increased spread of East Coast Fever, seventeen fresh outbreaks were reported.
- (b) Confirmed diagnosis of Rabies in the Northern Frontier Province.
- (c) A serious outbreak of contagious bovine pleuropneumonia. A large number of cattle belonging to the Masai were moved to the Southern Masai Reserve.

A considerable increase of pure-bred, imported stock is to be recorded.

Rinderpest.—There were four fresh outbreaks of Rinderpest, probably due to movement of infected buffalo. Vaccine has been extensively used on pure-bred imported cattle.

East Coast Fever.—Seventeen fresh outbreaks occurred. At first it appeared that this outbreak might have assumed alarming proportions but the disease was kept in check by careful supervision.

Contagious Bovine Pleuro-Pneumonia.—Two extensive outbreaks occurred during the year, both in native herds, north of the settled areas.

Anthrax.—Two outbreaks were reported during the year, serious mortality being prevented by vaccine.

Horse Sickness.—Six fatal cases were recorded.

Rabies.—On account of the importance of this disease, it has been dealt with under a separate heading.

Tuberculosis.—Two outbreaks occurred in North Kenya and 348 head of cattle were tested.

Sheep Scab.—This disease was more or less generalised, practically every herd inspected being affected.

Blue Tongue.—Following upon the heavy rains in the latter part of the year, a heavy mortality was recorded.

UASIN GISHU AND TRANS NZOIA VETERINARY DISTRICTS,
in addition this Veterinary District includes the
NANDI AND ELGEYO NATIVE AREAS.

SUMMARY OF OUTBREAKS OF DISEASE IN THE UASIN
GISHU AND TRANS NZOIA DISTRICTS IN THE YEARS
1927, 1928 AND 1929.

DISEASE	Number of Outbreaks during		
	1927	1928	1929
Rinderpest	20	32	1
Bovine Pleuro-pneumonia	10	3	2
Trypanosomiasis	3	1	6
Anthrax	5	17	4
Blackquarter	2	8	9
Tuberculosis	1	..	..
Bovine Lymphangitis	1	..	1
Ulcerative Lymphangitis	25	10	7
Epizootic Lymphangitis	3	..	1
Swine Fever	..	3	..
Heartwater	..	1	2
Foot and Mouth Disease	..	1	1
Muthiuko (Turning Sickness	..	5	..

In 1929 there were two outbreaks of Contagious Abortion and six of Anaplasmosis Accordia.

Rinderpest.—One outbreak was reported during the year. 13,678 cattle were double inoculated by the Rinderpest Service. Owing to the success, the Department has been requested to carry out compulsory Rinderpest inoculations during 1930 and every other year thereafter.

Contagious Bovine Pleuro-Pneumonia.—Two outbreaks were confirmed and controlled by strict quarantine measures and vaccination of all stock.

Anthrax.—Four outbreaks occurred, two among pigs.

Bovine Contagious Abortion.—Two cases were confirmed by Laboratory tests.

Blackquarter.—Nine outbreaks were reported and were dealt with by vaccination.

Foot and Mouth Disease.—One outbreak occurred.

Ulcerative Lymphangitis.—Seven outbreaks were confirmed.

Trypanosomiasis.—Six fresh outbreaks of this disease were confirmed. Experimental treatment was carried out on five farms and in these cases resulted in great improvement in the condition of cattle treated. The possibilities of the treatment are discussed elsewhere in this report.

GILGIL VETERINARY DISTRICT.

This area includes the Kijabe, Naivasba, Nakuru, Thompson's Falls and Ravine Districts.

SUMMARY OF OUTBREAKS OF DISEASES DURING THE YEARS 1927, 1928 AND 1929.

DISEASE	1927	1928	1929
Rinderpest	18	11	3
Bovine Pleuro-pneumonia	7	3	..
East Coast Fever	16	9	9
Trypanosomiasis	3	1	..
Blackquarter	7	1	1
Anthrax	11	14	5
Foot and Mouth Disease	12	3	4
Horse Sickness	2	4	..
Ulcerative Lymphangitis	3	5	..
Epizootic Lymphangitis	2	1	1
Contagious Bovine Abortion	1	5	3
Swine Fever	1	4	..
Sheep Pox	1	..	2
Anaplasmosis	..	15	7
Heartwater	..	3	1
Redwater	..	3	..

In addition the following outbreaks occurred in 1929 :—

Blue Tongue, 2; Actinomycosis, 1; Laikipia Lung Disease, 1.

Rinderpest.—Three outbreaks occurred, one being dealt with by vaccine.

East Coast Fever.—Nine outbreaks occurred in clean areas, but as in North Kenya they were controlled by prompt measures. A special staff was detailed to cope with the situation.

Sheep Pox.—Two severe outbreaks occurred.

Blue Tongue.—Two outbreaks were reported with a severe mortality.

LUMBWA VETERINARY DISTRICT.

This District includes the Kisumu, Londiani, Molo, Sotik and Kericho Districts and Lumbwa Native Reserve.

SUMMARY OF OUTBREAKS OF DISEASES IN THE LUMBWA DISTRICT DURING THE YEARS 1927, 1928 AND 1929.

DISEASE	1927	1928	1929
Rinderpest	1	21	2
Bovine Pleuro-pneumonia	3	..	..
East Coast Fever (Molo Clean Area)	3	12	6
Blackquarter	2	1	..
Ulcerative Lymphangitis	2	..	5
Trypanosomiasis	5	2	2
Foot and Mouth Disease	5	..	..

In addition the following outbreaks occurred in 1929 :—

Horse Sickness, 5; Sheep Pox, 1.

Rinderpest.—Two outbreaks were recorded during the year. 22,706 cattle were inoculated with a mortality of 2½ per cent. The highest mortality occurred among the cattle in the Molo area, where a heavy mortality in calves was experienced, which was inevitable as inoculations have not been carried out in the district for many years and the young calves of sick cows had a poor chance of recovery.

East Coast Fever.—Six outbreaks occurred in the clean areas and at present seventeen farms remain in quarantine. The entire absence of fencing and indifferent dipping are the reasons for no advance in this district.

Horse Sickness.—Five outbreaks occurred during the year with heavy mortality. Experimental vaccination was used in one instance with success.

Ulcerative Lymphangitis.—This disease was noted in five instances.

Contagious Bovine Abortion.—This is very prevalent in the district and the cause of much sterility in cows.

Squatter Stock.—With the active co-operation of the Administration and settlers of the district some 25,000 squatter cattle have been removed from the Molo, Meru and Londiani areas, back to the Lumbwa Reserve. It is hoped this general move of squatter stock will assist in the control and prevention of stock disease in these areas.

MOMBASA.

East Coast Fever is prevalent on the island and a number of deaths have occurred.

IMPORTATION OF STOCK—TABLE OF COMPARATIVE RECORDS.

The following animals arrived from overseas and were railed to Up-country Stations :—

	1926	1927	1928	1929
Horses	36	54	42	12
Cattle	52	130	80	119
Dogs	118	116	103	103
Sheep and Goats ..	185	97	348	92
Pigs	16	10	25	15
Cats	7	2	1	2
Red Deer	17	..	4	..
Rabbits	..	35	19	11

Coastwise traffic arriving on Mombasa Island :—

	1926	1927	1928	1929
Donkeys	57	76	10	8
Mules	..	..	2	..
Cattle	323	2	5	138
Camels	30	11	1	12
Sheep and Goats ..	3,196	192	768	168
Dogs	..	..	..	7

Stock arrived at Mombasa from Up-country Stations :—

	1926	1927	1928	1929
Cattle	526	477	450	579

Stock dealt with at the Veterinary Station, Makupa, arriving by road from the Mainland :—

	1926	1927	1928	1929
Cattle	3,669	5,415	4,968	4,789
Donkeys	28	91	69	42
Sheep and Goats ..	14,550	28,113	22,733	23,894

Inspection of hides at Mombasa :—

	1925	1926	1927	1928	1929
Hides (bundles)	14,293	11,985	8,600	8,544	5,219
Skins (bundles)	2,486	1,060	2,187	3,184	2,912

Stock slaughtered at Mombasa :—

	1926	1927	1928	1929
Cattle	4,491	5,663	5,915	6,296
Sheep and Goats ..	19,457	19,910	18,988	19,043

The Veterinary Quarantine Station was gradually demolished during the year by the excavation works for the building of the Macupa Causeway, and the work is continued under great difficulties. A new quarantine station will be erected on the main land adjacent to the causeway.

VETERINARY SERVICES—NATIVE RESERVES.

It is one of the objects of the Veterinary Service to aid in the development of the natural resources of this Colony, upon which they largely depend, by enabling pastoral industries to be undertaken under the most advantageous conditions, and by the prevention and control of animal disease. One of the principal handicaps which the pastoral natives have to face is the loss entailed by disease.

The Veterinary Service should be the custodian of animal life, and should safeguard the health of the vast numbers of livestock, the value of which it is impossible to compute, but upon which much prosperity may depend. The people of the country to-day, except the natives themselves, appear to realise that in this country the actual convertible capital value of the livestock, if realisable, exceeds that of all other industries combined.

The number of cattle in the Colony is recorded to be about 3½-million head, based on a general estimate, without census. This figure, as each stock census of a particular district is made, is found to be widely wrong. A more correct approximate figure of the native cattle in this Colony would be from six to seven million.

The great importance of maintaining a competent veterinary organisation in an agricultural country cannot be overestimated, as the livestock industry is constantly exposed to serious loss by the action of contagious and infectious disease.

The scope of the Veterinary Service should not be limited to the assistance given in connection with disease, as such, but should also function in an advisory and educative capacity from the knowledge of animal husbandry acquired by its members by training and experience.

Yet in this Colony, which depends solely on its agriculture, it is strange to find apathy with regard to the Veterinary Services which alone can keep the livestock of the country free from the scourge of disease. The assistance that can be given to the stock industry is of real value, as upon it depends the health of the stock population; the prosperity of whole communities is in other countries mainly dependent upon the animal industry. This fact is far from being fully realised and only in isolated instances has it been recognised by Governments.

The chief object of a Veterinary Service is to prevent the spread of animal disease, as the significance of the life of the individual animal is small in comparison with that of the herd, and it is chiefly the devastating sweep of transmissible disease which must be guarded against. It is preventive and not curative measures which must be stressed, and a Veterinary Service must always keep such functions of control in view and not forget that the health of livestock is not a matter of sentiment, but of economics. New Zealand to-day is dependent upon the money she receives from the export of primary products derived from domesticated animals.

1. *Disease Control.*

Disease control as carried out by a Veterinary Service may be preventive or curative.

The Veterinary units which are operating in the Nyanza and Kerio Provinces are at present time practising the curative form by inoculating all sick animals and those in contact with them. When disease is prevalent in a chronic form (endemic or enzootic) the only sure system of eradication is to confer an immunity on all animals involved, as otherwise the disease will remain, or reappear, so long as there are any susceptible animals to keep up *foci* of infection.

Proof of the success of this form of eradication can be found to-day in the comparative absence of Rinderpest in the North Kavirondo and Machakos Native Reserves.

The preventive form of control is advocated for provinces where the incidence is light, such as the Masai and Northern Frontier Provinces, where disease can be dealt with by the isolation of sick animals and strict quarantine kept on them. This method, however, leaves the animals susceptible to disease, and a possible ingress of disease by game, etc., must always be watched. This system is advocated for pastoral tribes whose habits are nomadic, where the grazing areas are extensive and sparsely populated. The technical staff required is in consequence small, provided a trained native personnel is available for reliable scouting work.

If quarantine measures are ineffective and in consequence diseases spread, then the curative form of eradication is resorted to.

2. *Improvement of Native Stock.*

Improvement of native cattle by better methods of animal husbandry.

Before any system for the improvement of native stock can be introduced there is a necessity to make provision for :—

(a) A system of disease control.

(b) The disposal of surplus native livestock.

In regard to the latter provision, an interim report of a committee appointed by Government has been presented, and recommendations made for consideration.

The former provision of disease control has been adopted in certain districts of the Nyanza, Kerio and Ukamba Provinces, but no control has been made in the Seyidie, Kenya, Northern Frontier and Masai Provinces.

The better management and feeding of stock is included.

African Veterinary Training Centres are being established and when fully equipped will be able to train many natives at a time in general technical veterinary work. At the present time facilities are given for the training of veterinary orderlies and scouts in Government employ.



DAIRY AT THE NGONG AFRICAN TRAINING CENTRE (BUILT BY AN AFRICAN ARTISAN)

The conservation of native livestock in this Colony depends upon a system of disease control coupled with better animal management, which if brought to a successful issue will bring better health and prosperity to the native stockowners in this Colony.

IMPROVEMENT OF KENYA NATIVE CATTLE FOR DAIRY PURPOSES.

Various breeds of native cattle are indigenous to Kenya, forming the sole herds of native owners, and the basis of the herds of grade cattle owned by Europeans. The native cow is the type of animal that has evolved under local conditions and survived; consequently it is the one best suited constitutionally to the natural conditions of the Colony.

Her capacity to produce milk under modern methods of dairy husbandry has never been ascertained, and as the leading breeds of European dairy cattle have been developed from original native stock by careful breeding, adequate feeding and good management, it is suggested that the potential resources of the Kenya native cattle be exploited along similar lines, and that this work be commenced at the Veterinary Department's experimental centre at Ngong, in conjunction with the training of pastoral natives in animal husbandry.

AFRICAN VETERINARY TRAINING CENTRES.

African Veterinary Training Centres are slowly being established at Ngong, in the Masai Reserve; at Maseno, in the Central Kavirondo Reserve; at Isiolo, in the Northern Frontier Province; and at Machakos, in the Machakos Native Reserve.

A number of native heifers were purchased during the year with the object of teaching the natives better methods of animal husbandry. The progress so far is described under the activities of the Ngong African Training Centre.

A number of sheep experiments in breeding and management, etc., as detailed in the Annual Report of 1928 were commenced at, and are described under, the Report of the Isiolo African Veterinary Training Centre.

Machakos and Maseno, although not yet in a position to function as African Training Centres, have made satisfactory progress towards final preparation.

No financial assistance has been given by Local Native Councils in helping to establish these Training Centres.

MASENO AFRICAN VETERINARY TRAINING CENTRE,
CENTRAL KAVIRONDO.

Through the courtesy of the Provincial Commissioner, Nyanza Province, about 500 acres of reverted Government land at Maseno was handed over to this Department for the establishment of an African Training Centre.

250 acres have been completely fenced.

The swamps within the area were drained by digging one-and-a-half miles of trenches.

About fourteen acres of sisal plants were removed and plots of buckwheat, lucerne, oats and maize were planted. A furrow, 900 feet in length, was made to irrigate these plots.

Thirty-nine heifers were purchased towards the end of the year from various locations as it is hoped to demonstrate to the local natives the methods and systems of cattle breeding and calf rearing which have been successfully commenced at the Ngong African Veterinary Training Centre.

Four substantial poultry houses and runs have been erected and work on the breeding of poultry will commence during 1930.

A milking byre fifty feet by twelve feet and a calf shed sixty feet by twelve feet were built during the year.

MACHAKOS AFRICAN VETERINARY TRAINING CENTRE.

After a long negotiation, a thousand acres of land were obtained in the Machakos District in the township area. This added area to the existing Veterinary Reserve has been boundary fenced and is being divided into paddocks with the idea of demonstrating to the Akamba native the principals of improvement of pastures. The area chosen for establishing the African Veterinary Training Centre in Machakos showed bad soil erosion and wash and was thickly covered with thorn bush. With the aid of fencing and the removal of the bush, an excellent crop of grass has resulted after the recent rains without any artificial aid or planting.

In order to teach the African native the possibility of always providing sufficient food for his stock and thereby to keep up an average flow of milk in their milch stock, opportunities are taken in the African Training Centres where cattle are kept to plough the land and cultivate artificial crops.



NGONG AFRICAN TRAINING CENTRE---MILKING SHED BUILT AT A COST OF £33

In the Machakos African Training Centre a small area has been experimented with and lucerne and subterranean clover have been sown. The lucerne has grown in a very patchy manner. Another variety of lucerne will be tried during the next rains.

The clover crop promises well and it is proposed to extend the acreage during the next season's rains.

During the year fifty-six heifers were purchased locally and are due to calve soon, and it is hoped that facilities will be available to train pupils on the lines adopted at the Ngong Centre during the year.

The staff during the year erected a temporary store, boys' quarters and cow and calf sheds.

AFRICAN VETERINARY TRAINING CENTRE, NGONG.

The report of this native African Training Centre indicates that great progress has been made in its development, and it should be noted that a great deal of necessary work has been done by the staff in the erection of the various buildings required.

It is hoped to extend the scope of the training during the coming year, as the facilities for tuition are now becoming much more extensive.

As this centre is situated on land owned by the Masai, it may be necessary to give a preference to Masai natives when obtaining pupils; the intention being in time to have a training establishment entirely for the benefit of that tribe.

The results achieved at Ngong are described and recorded and have greatly impressed both European and native visitors who have made an inspection of the centre. The milk records of native cows will repay a close study, particularly when comparing the convertible milk quantities into cream, butter and ghee with the ratio (as mentioned in the Annual Agricultural Report, 1928, page 28), of 2.25 gallons milk to 1 lb. butter, etc.). It is found, on the yield of milk from twenty-seven native cows not specially selected but hand milked, that 10 lb. of milk produces 1 lb. of cream; $1\frac{1}{2}$ lb. cream makes 1 lb. of butter and 10 lb. of butter clarify into 7 lb. of ghee.

Careful thought has been given to the rearing of native calves up to the age of three months, and the system could be adopted generally as a means of producing good, healthy native calves at a low cost.

The calf-feeding experiments which have been carried out show the possibilities of the rearing of weaner animals on a practical and economic scale.

In view of the heavy mortality of sucking and weaner calves throughout the Colony from digestive diseases, and the prejudicial effects of such diseases on the constitution and stamina of the survivors, these experiments would show that such losses are not inevitable.

Another lesson the Ngong experiment gives is the value of hygienic conditions coupled with the pounding, paddock fencing, and dipping of stock, even in the absence of disease.

No disease is reported among the stock during the year in the Training Centre, except Contagious Abortion, in spite of the fact that owing to drought conditions and disease the Masai stock grazing around the boundary fence were dying from many diseases, principally tick-borne, and suffered from unthriftiness owing to the poorness of the pastures and the filth of the manyattas.

The Annual Report of the Veterinary Training Centre, Ngong, by the officer in charge (Captain R. Scott Little) is appended in extenso, with a few minor alterations.

Pupils.

Twenty-four Turkana and Samburu pupils were discharged at the beginning of May, after a year's training, as the changed conditions made it apparent that there would be no work available for them in their own reserves.

Numbers.

The pupils at present are twenty in number, of whom seven are Masai, five are Wakikuyu, five are Suk, two are Wakamba and one Kavirondo.

The pupils are given training in :—

1. The proper methods of handling cows at the time of calving and during milking.
2. Correct methods of double handed milking of cows in the absence of the calf.
3. The use of and cleaning of a milk separator.
4. The recording and weighing of milk quantities.
5. The hand rearing and feeding of calves.
6. The preparation of butter and ghee.
7. The preparation of hay.

8. The preparation of shade-dried hides.
9. The dipping of cattle.
10. The preparation of shambas by planting for the growing of forage crops.

The ploughing is done with a single furrow "Jumbo" plough.

All the outside work is done after the cows are milked in the morning. The pupils attend school in the afternoon, where they are taught the elements of reading, writing and arithmetic to enable them to understand the value of the work actually being done.

The time-table is as follows :—

7 a.m. to 9 a.m.	...	Milking.
9 a.m. to 10 a.m.	...	Food.
10 a.m. to 2 p.m.	...	Shambas, Hides, etc.
2 p.m. to 3 p.m.	...	Free.
3 p.m. to 4 p.m.	...	School.
4 p.m. to 5 p.m.	...	Free.
5 p.m. to 6.30 p.m.		Milking.

Buildings.

The following construction work was carried out during the year.

1. A milking shed to accommodate twenty cows.

This was built of rough forest timber, and thatched with grass. The windward side has a thatched wall up to within a foot of the eaves, to ensure through ventilation, and yet act as a windbreak. The floor is of beaten murrum only, in the one half, the other half having a strip of concrete where the cows stand. A feeding passage is in front of the cows. The cows are fastened by means of two upright moveable posts closing at either side of their necks.

This type of shed is simple, effective and cheap, inasmuch as both timber and grass are available on the farm.

It is not considered that the addition of the strip of concrete is of any material advantage. The cows are in the shed only for about an hour-and-a-half, twice a day.

At one end is a small, galvanised iron shed with a concrete floor. This is used for the separating of the milk for convenience and cleanliness in handling the milk for feeding the calves, and for recording the milk production of the cows.

The general dimensions of the shed are :—

Length—116 feet.	Breadth—14 feet.
Height to eaves—5 feet.	Height to ridge—15 feet.
Feeding passage in front—3 feet.	Length of stalls—7 feet.
Width of stalls—4 feet.	Passage behind—4 feet.

A small paddock is provided close to the shed in which those cows stand which are not actually being milked.

2. A milking shed to accommodate ten cows.

This is built in a much more elaborate and substantial manner. The floor is of concrete and is sloped to facilitate drainage and cleaning. The timber is sawn and painted with solignum. The roof and windward wall are of plaited reeds. The cost was about £50. The general dimensions are as follows :—

Length—51 feet.	Breadth—18½ feet.
Height to eaves—8 feet.	Height to ridge—16 feet.
Feeding passage in front—5½ feet.	Length of stall—5 feet.
Width of stalls—4¾ feet.	Width of drainage channel—17 inches.
Depth of drainage channel—6 inches.	Passage behind stalls 5 feet 10 inches.

A small paddock is provided as in the case of the other shed.

3. A building for use partly as a school, and partly as a store for material such as arsenite of soda, paraffin, disinfectant, etc.

This was built of galvanised iron, has a concrete floor and is vermin proof. This complete with two doors, two double windows, guttering, etc., cost about £100.

The building is divided into two equal halves, separated by a galvanised iron partition. The general dimensions are :—

Length—50 feet.	Breadth—18 feet.
Height to eaves—8 feet.	Height to ridge—13 feet.

A verandah extends all the length of one side and is six feet wide.

4. A new store of galvanised iron with a concrete floor, four double windows, and one double door.

This is also vermin proof and contains the general stores of the station. This was built by the Public Works Department at an estimated cost of £196.

The dimensions are :—

Length 35 feet.	Breadth—18 feet.
Height to eaves—9½ feet.	Height to ridge—15½ feet.

5. A weighbridge by “Pooley’s” to weigh up to fifty cwt. This was installed by the Public Works Department at an estimated cost of £30. It is used for the weighing of cattle and material such as feeding cake and maize meal.

6. A large *banda* has been built in the native lines consisting of ten rooms under one roof.

This is made with mud walls and grass roof. All the existing circular *bandas* have been re-roofed and their walls re-made, with the exception of six which were demolished.

A better type of *banda*, together with various outhouses, has been built for the native clerk and the driver of the departmental lorry.

Two old sheds used as cow sheds and loose boxes have been demolished. Three old buildings which were used as stores for Government property were likewise pulled down.

An old cattle boma with boys’ huts was pulled down. In all cases any material of any value saved out of the old buildings was used in one way or another in the new ones.

The dairy which was commenced towards the latter part of 1928 was completed this year. The dimensions are :—

Length—23 feet.	Breadth—16 feet.
Height to eaves —9 feet 8 inches.	Height to ridge—17½ feet.

An addition is being made in the form of a semi-open room for use as a ghee kitchen and for cleaning dairy utensils. The dimensions will be :—

Length—12 feet.	Breadth—16 feet.
Height of walls—8 feet.	Height to ridge—17½ feet.

Fencing.

During the year approximately one half of the area included in the farm has been sub-divided into paddocks, five in number. A number of small paddocks have been fenced off around the calf sheds and the cow houses. It is hoped by these measures to graze the land more thoroughly and to reduce the number of herd boys required, and to reach more rapidly a stage when the present five days' dipping may be changed to one of seven days' interval. All fencing is six strands of barbed wire with wooden posts, strainers and droppers.

Access from paddock to paddock is by means of tubular iron gates, the tops of which are wrapped with barbed wire. On account of the perpetual stream of natives passing to and fro over the grazing areas and past the houses and sheds, all gates will be locked in future.

Trees.

About 6,000 young kei apple trees were planted in a strip of ground prepared along the inside of the boundary fence. The failure of the rains, however, has resulted in the majority dying.

Rainfall.

During the year 27.45 inches of rain were recorded at the station, the monthly distribution being as follows :—

January —	July —
February —	August 1.32
March 0.90	September 1.05
April 7.54	October 1.40
May 6.31	November 4.10
June 1.00	December 3.83

Water Supply.

The supply of water from the borehole and windmill was regular and satisfactory.

The supply from the ram was not satisfactory, on several occasions failing altogether.

After several visits the Public Works Department were able to adjust things so that it functioned properly.

Dipping.

All cattle were dipped at five days' interval, with the exception of the work oxen, which by reason of work to be done were dipped every Sunday morning, i.e. at seven days' interval. No cases of East Coast Fever have been recorded during the year. Tick life appears to be very scarce, and it is hoped that with proper rotational grazing, an even greater reduction may be achieved.

All animals on the farm from the age of one week are regularly dipped and hand dressed.

The results of the last seven dip analysis give an average of 2 per cent above seven days' strength.

Hides.

The proper preparation of shade-dried hides forms part of the instruction given to the native pupils. The hides are obtained from the local Somali butchers, who supply them free, in return getting their hides properly prepared free of charge.

The number of hides dealt with during 1929 was 687, the average weight being :—

I. On flaying	.. .. .	40 $\frac{1}{2}$ lb.
II. After being properly dressed		34 „
III. After shade-drying	.. .. .	16 „

All the above were native hides.

It is hoped with extension of the drying shed more hides may be dealt with, giving greater opportunity for the instruction of pupils. One hundred hides belonging to the station were sold for Sh. 440. Many were spoiled by lack of facilities for storage at the time.

Ghee.

During the year a beginning was made with the preparation of ghee, and in the month of October nine tins were sold realising a price of Sh. 602/50.

Game.

Very little trouble was experienced with game. This may have been due to the prolonged drought in the Masai Reserve causing the game to wander far afield in search of water. Hyænas which had been a source of trouble in the past caused only a few deaths, and these only among animals which had strayed.

Crops.

Lucerne.—About half an acre was planted as an experimental plot at the middle of March. The first crop was cut at the beginning of August, and weighed when dried 4 cwt. The second crop was cut on October 10th and weighed when dried $7\frac{1}{4}$ cwt. The third crop was cut on November 28th and weighed when dried $7\frac{3}{4}$ cwt. This was without irrigation and was on a light type of black cotton soil and is equivalent to about two tons to the acre for the three cuttings. A fourth crop is now being cut.

A second plot of *Lucerne*, one acre in extent, was planted towards the end of the year, i.e. November 20th, on a slightly heavier type of black cotton soil. This seems to promise better results than the original plot. The *lucerne* used so far has been "South African Provence."

Subterranean Clover.

Three acres have been planted, one acre with Superphosphate of Soda at the rate of 1 cwt. to the acre, and two acres without. Both were planted at the beginning of November. Up to the present the manured crop has grown more rapidly than the other one, both are, however, growing well.

Oats.

Two acres of Algerian oats were planted on a kind of black cotton soil on November 21st, at the rate of $3\frac{1}{2}$ bushels to the acre. So far the crop is growing very well.

Maize.

Nine acres of maize were planted for ensilage and cut for that purpose, a pit fourteen feet by fourteen feet being prepared. Owing to the excellence of the grazing and the night and day herding of cattle, no opportunity has yet arisen to use it.

Hay.

Three stacks of hay were made during the year. The hay has been found very valuable as food for the calves.

Some nine acres of new land have been ploughed up; the above-mentioned crops being planted on about half; the remaining half is being prepared for other crops.

Disease among Stock.

With the exception of Contagious Abortion, there were no cases of infectious or contagious disease. All the cows were tested twice, and twenty-four cows were found to be infected. These were disposed of at once, to the Laboratory. It is proposed to test all the animals again. Two other cows which were infected died from natural causes. As there were 152 cows to begin with this gives a percentage infection of seventeen.

Cattle (general).

The cattle on hand on December 31st, 1929, were :—

Bulls, 3; Cows, grade, 5; Calves, 38; Bullocks, 48;
Cows, native, 117.

The three bulls are Boran; of the cows, thirty-seven are Machakos, and eighty are Boran. Up to the present it would seem that the Machakos cows are of a better milking strain than the Boran. This, however, may be due to the breeding of the Boran cows, as all these were purchases from a settler who for some years has gone in for beef cattle. During the year eighty Boran heifers were purchased; the first consignment of fifty were all in calf on their arrival. The grade cows are kept mainly for the purpose of teaching pupils how to milk properly with both hands. It is not proposed to keep the calves of these animals for breeding purposes, as the work of the station is concerned with the development of native cattle only. A number of oxen which had been trained at the station were transferred to various up-country stations.

A simple system of recording milking and breeding has been instituted. So far as our experience has gone it would appear to show that many native cows have no milk at all when they calve, whether the calf is left with the mother or taken away. Of the heifers which have calved so far, i.e. forty-six in number, fourteen were cast for this reason, that is 30 per cent. Two others were cast because their teats were too small to be handled.

Milk Records of Native Cows.

So far as is known, no properly regulated work has been done up to the present with the native cow of this country as regards quantity and quality of milk or length of lactation period. A beginning has been made at this station, and so far as the work has gone, the results have been very satisfactory.

At present twenty-seven cows are being milked. No special feeding has been adopted. In considering the following figures and results it must be borne in mind that the cattle are of the first generation, were not specially selected, and that nothing is known of their ancestry.

MONTHLY TOTALS OF MILK CONVERTED INTO CREAM
BUTTER AND GHEE.

MONTH	Milk	Cream	Butter	Ghee
	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>
July	1,942	181	122	96
August	1,942	186 $\frac{3}{4}$	127 $\frac{1}{4}$	99 $\frac{1}{4}$
September	1,980	188 $\frac{1}{4}$	128 $\frac{1}{2}$	100 $\frac{3}{4}$
October	2,156	206	140	105 $\frac{1}{4}$
November.. ..	2,952 $\frac{1}{2}$	289 $\frac{1}{4}$	194	146 $\frac{1}{2}$
December	2,992 $\frac{1}{4}$	303 $\frac{1}{2}$	207 $\frac{3}{4}$	158 $\frac{1}{4}$

It is to be noted that approximately—

10 lb. of milk=1 lb. of cream.

1 $\frac{1}{2}$ lb. of cream=1 lb. of butter.

10 lb. of butter=7 lb. of ghee.

COMPARATIVE MILK YIELDS.

A comparison is given of the milk yield of two cows over relative periods of their first and second lactations.

No. 15	Days	1928	No. 40	Days	1928
		<i>lb.</i>			<i>lb.</i>
October	24	200	February.. ..	7	52 $\frac{1}{4}$
November.. ..	30	336 $\frac{3}{4}$	March	31	312
December	31	303	April	30	226
	85	839 $\frac{1}{4}$		68	590 $\frac{1}{4}$

1st lactation=9 $\frac{1}{2}$ lb. per day

1st lactation=8 $\frac{3}{8}$ lb. a day.

	1929			1929	
	<i>Days</i>	<i>lb.</i>		<i>Days</i>	<i>lb.</i>
September ..	14	175 $\frac{1}{4}$	November ..	1	3 $\frac{1}{4}$
October	31	429 $\frac{1}{2}$	December ..	31	265 $\frac{1}{4}$
November.. ..	30	382		32	268 $\frac{1}{2}$
December	31	369 $\frac{1}{2}$			
	106	1,356 $\frac{1}{4}$			

2nd lactation=12 $\frac{1}{2}$ lb. a da.

2nd lactation=8 $\frac{3}{8}$ lb. a day.

MILK YIELDS AND PERCENTAGE OF BUTTER-FAT

	48	28	6	50	2	38	42	7	44	15
No of Heifer ..	24-6-28	17-3-29	17-3-29	27-2-29	19-4-29	16-5-29	28-5-29	15-7-29	18-7-29	8-10-28
Date of Calving ..	2,722½lb.	2,653lb.	2,754¾lb.	1,807½lb.	2,754lb.	1,076½lb.	1,580½lb.	1,451½lb.	850lb.	2,333lb.
Yield to date 31-12-29	4-6	5-9	5-8	6-9	5-0	5-0	4-0	..	..	4-8
Percentage of Butter-fat	5-0	5-3	5-0	6-0	5-1	6-2	4-2	..	..	7-0
April ..	6-6	5-8	5-4	6-2	6-0	7-4	5-0	6-1	5-8	8-5
June ..	6-7	6-2	7-2	9-5	6-8	7-3	6-4	7-3	6-0	..
August ..	6-6	7-8	7-5	..	7-5	7-6	7-0	8-2	6-2	..
October ..										
December ..										
AVERAGE	5-9	6-2	6-2	7-15	6-08	6-7	5-3	7-2	6-0	6-7
No. of Heifer	15	4	10	25	54	85	11	40	40	16
Date of Calving ..	17-9-29	20-9-29	8-10-29	1-11-29	1-11-29	20-11-29	20-11-29	22-2-28	30-11-29	7-4-29
Yield to date 31-12-29	1,356½lb.	1,212½lb.	835¾lb.	260½lb.	362½lb.	482½lb.	255½lb.	1,290½lb.	268½lb.	1,206½lb.
Percentage of Butter-fat										
April ..	..	..	..	..	..	..	..	5-4	..	6-8
June ..	..	..	..	..	..	..	..	4-2	..	6-4
August ..	..	..	..	..	..	..	..	5-6	..	7-2
October ..	5-3	5-8	..	..	..	..	..	6-2	..	9-0
December ..	4-5	5-5	6-5	7-5	7-2	4-0	6-0	..	5-4	9-4
AVERAGE	4-9	5-6	6-5	7-5	7-2	4-0	6-0	5-3	5-4	7-7

Calf Rearing.

The average weight of a native calf at birth is 35 lb.

The calves are taken away from the mother at birth and are completely hand fed, on whole milk for some time, after which a change is made to separated milk, the fat which is then absent being replaced by the fat contained in concentrates. The calves are kept in small pens, are groomed daily and are dipped from the age of one week. The pens are cleaned out daily and are disinfected twice a week. When the calves reach the age at which concentrates are fed, hay is given in racks at night. After the age of one week the calves are herded out in the open all day. They are weighed at regular intervals to keep check on their progress.

Some typical examples are given below :—

No.			Weight at birth	Date of birth	Weight at 18-12-29	Average daily gain
			<i>lb.</i>		<i>cwt. gr. lb.</i>	<i>lb.</i>
3	..	..	34	26-6-28	3 3 6	0.68
21	..	..	28	9-9-28	3 2 1	0.55
15	..	..	38½	8-10-28	3 3 21	1.11
58	..	..	31½	10-9-28	3 1 3½	0.77
23	..	..	40	20-3-29	3 1 11	1.16
40	..	..	40	22-2-29	3 0 25	1.02
6	..	..	38	17-3-29	3 0 10	1.06
2	..	..	33	19-4-29	2 1 9	0.88

This represents an average gain of nine to ten pounds a day.

After some preliminary trials, the following system of calf feeding has been adopted and has proved very successful.

FIRST WEEK—

1st day—(colostrum)—1 lb. morning and evening.

2nd day—(colostrum)—1 lb. morning and evening.

3rd day—whole milk—1½ lb. morning and evening.

4th, 5th, 6th, 7th days as on 3rd day.

SECOND WEEK—

All the week—whole milk—2 lb. morning and evening.

THIRD WEEK—

All the week—whole milk—2½ lb. morning and evening.

FOURTH WEEK—

All the week—whole milk—2½ lb. morning and evening.

This 5 lb. of whole milk is fed until the change over is made to separated milk at the end of the second month.

The change to separated milk and concentrates is now made over a period of about eight days. When this change is completed, then a small quantity of the concentrate is given. The concentrates are made up in bulk of maize meal 100 lb., sim-sim cake (crushed) 100 lb., bran 50 lb. Very small amounts are given to begin with, and as the calves get older, the amount is increased, but never exceeds 1 lb. a day. From records which have been kept we can say that up to the time of weaning, i.e. about six months, the cost of rearing a well growing calf does not exceed Sh. 1/25 a month for concentrates.

Feeding Experiments—Calves.

The following experiment in calf feeding was carried out. (See tables A and B, pp. 144-6.)

It is proposed to institute further experiments when material and opportunity are available, although it is not to be understood that the main function of the station is that of experimental feeding.

Visitors.

During the latter part of the year the station was visited by many persons who were interested in the work which is being carried out. The visitors included many settlers, Government officials and a number of native headmen from various tribes. All assistance was given to help these persons to understand the general principles of the work, and it is hoped that as a result some slight indication has been given that in this country improved methods of stock husbandry can be adopted without an impossible overhead cost. Most important may have been the effect on the mind of those natives who saw the ordinary native cows being treated in a way quite new to them.

Slaughter Stock.

The following animals were passed out of the Masai Reserve into Nairobi for slaughter purposes :—

Cattle—7,683

Sheep and Goats—376.

CALF FEEDING EXPERIMENT, NGONG.

TABLE A.

The aim of the experiment was to demonstrate the effect of the substitution of separated milk in place of whole milk in the daily ration of calves during the later stages of the hand rearing period.

Two groups of calves, five in each group; balanced in respect of sex, age and live weights, were placed on experiment for a period of three months.

Their rations were as follows:—

GROUP I.

DAILY RATION.

Whole milk—5 lb. per head per day during 1st month on experiment.

Whole milk—4 lb. per head per day during 2nd month on experiment.

Whole milk—3 lb. per head per day during 3rd month on experiment.
Plus concentrates.

GROUP II.

WHOLE MILK— SEPARATED MILK—

4 lb. 3 lb. per head per day for first two weeks.

2 lb. 4 lb. per head per day for second two weeks.

2 lb. 4 lb. per head per day for second month.

Plus concentrates. 4 lb. per head per day for third month.

The total amount of whole milk consumed by Group I during the period was 165 gallons; by Group II, 86 gallons. Each group consumed approximately the same weight concentrates during the experiment—about 370 lb., or 74 lb. per head in three months.

The calves were weighed at the commencement of the experiment and at intervals throughout. The figures are given below in detail.

TABLE B.
WEIGHT OF CALVES (EXPERIMENT BEGAN 13-8-29, FINISHED 11-11-29).
GROUP I.—(Whole Milk, plus Concentrates).

Number of Calf	13-8-29	27-8-29	10-9-29	24-9-29	8-10-29	22-10-29	11-11-29
	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>
No. 6	181	218	232	246	263	280	297½
„ 32	142	173½	186	199	224	237	253½
„ 15	121	151½	163½	177	197	216	239
„ 20	84	94	90	104	109½	100	119
„ 2	107	131	139½	156½	171	185	212
Total weight 5 calves	635	768	811	882½	964	1,018	1,121

Total initial weight=635 lb.

Gain for period=486 lb.

Total final weight=1,121 lb.

Average gain=97.2 lb.

TABLE B.—(Contd.)
WEIGHT OF CALVES (EXPERIMENT BEGAN 13-8-29, FINISHED 11-11-29).
GROUP II.—(Whole Milk, Separated Milk, plus Concentrates).

Number of Calf	13-8-29	27-8-29	10-9-29	24-9-29	8-10-29	22-10-29	11-11-29
	lb.	lb.	lb.	lb.	lb.	lb.	lb.
No. 8	165	212	223	244	264	260	302
„ 23	181	220	240½	263	277½	300	318
„ 26	100	152½	161	174	186	203	214
„ 38	92	118	127	141	144	157	172
„ 42	92	126	140	154½	168	182	192
Total weight 5 calves	630	828½	891½	976½	1,039½	1,102	1,198

Total initial weight=630 lb.

Total final weight=1,198 lb.

Total gain for period=568 lb.

Average gain=113.6 lb.

Group II showed an increase of 16.2 lb. per head over Group I. No. 20 in Group I was not a thrifty calf, its weight showing fluctuations, but if it be excluded, the balance is still in favour of Group II.

CONCLUSION.

The experiment indicates that a considerable saving in whole milk can be effected by the substitution of separated milk, and that beneficial effects as shown by live-weight increase have been secured. In herds where the percentage of butter-fat is uniformly high as in the Ngong native herd, the reduction of the amount of whole milk fed to calves is not without its economic importance.

AFRICAN VETERINARY TRAINING CENTRE—ISIOLO.

The experiments laid down for the improvement of native sheep were commenced during the year, although the original group of breeding experiments, as described in the Annual Report of 1928, were revised and reduced in number.

Imported Sheep.

A pure bred Black Headed Persian flock was imported from South Africa and sent to Isiolo in easy stages.

Generally speaking the flock has maintained a fair condition, although the weather conditions of the last six months of the year were varying, from excessively dry weather in August and September, being followed by abnormally heavy rain of an unusually long duration.

In consequence the flock experienced a severe setback, especially as the sheep were highly susceptible to all the local contagious diseases.

Ninety-eight of the original flock of 134 rams, ewes and lambs sent to Isiolo have survived and deaths have been caused by Blue Tongue, Lung Sickness, Heartwater, Anthrax and other various causes, including plant poisoning.

The ewes lambed down in December and January to a fairly even lot of lambs; the average birth weight recorded was 5 lb. 2 oz. Fortnightly weights were taken and the lambs showed an average increase of 3 oz. daily, over a period of fifty days.

The lambs are thriving well and give every indication of developing into healthy animals.

This record does not present a promising picture, but better results are expected from the lambs of the pure bred flock, bred under local conditions, and it is hoped that a pure bred flock of Black Headed Persian sheep may be maintained at this centre.

In order to improve the indigenous type of sheep the introduction of a fresh strain of blood of a suitable type and breed of sheep was resorted to for experimental purposes.

The native sheep of the Colony are of a degenerate type brought about by haphazard methods of breeding and general control of the flocks.

Lumbwa, Masai and Gabbra ewes, with two teeth up, were purchased, and an average lot of ewes have been served by Black Headed Persian rams, a Gabbra flock of ewes with a Gabbra ram being kept as a control.

The experiment of cross breeding is still in an early stage, and for the moment it is only possible to record a few generalities.

The investigations are designed with a view to determining any constitutional deficiencies, resistance to disease, suitable means of increasing weight, etc.

From the experience already gained it is possible to gauge the adaptability of the various flocks to the local conditions of climate and disease.

Samburu Sheep.

The flock of Samburu ewes has made good progress and maintained condition well and has shown adaptibility to the local conditions of Isiolo.

This type possesses a predominant red colour, is light boned and clean cut with a more drooping tail than the other types of the Northern Frontier Province. The ewes, to Black Persian cross, are not yet lambed down.

Masai Sheep.

These, like the Samburu sheep, have thrived well, at Isiolo. These sheep have characteristics similar to those of the Samburu sheep, which they resemble in appearance, colour and conformation; but the bone is heavier and the fatty tail is rather more highly set up. Fifteen of the bigger ewes of the flock were served by a Suffolk ram and the remainder were crossed with the Black Headed Persian rams. Lambs are expected in May.

Gabbra Sheep.

The Gabbra sheep are of the Black Headed type, being light boned with short haired white fleece. A flock of one hundred ewes was purchased at Laisamis, in the arid regions of the Northern Frontier Province.

Unfortunately, about 50 per cent of the ewes were found pregnant on arrival and the pregnant ewes now form the control native stock.

The Gabbra type has not withstood the local conditions with the same success as the red sheep, due no doubt to the dissimilarity of the climates of Isiolo and the northern arid regions.

The control flock lambed down irregularly over a period of several months.

The average birth weight recorded was 4 lb., and the daily increase in weight was 1.9 oz. over an average period of thirty-two days.

These lambs were not thrifty and several have died as the result of malnutrition. This may be due to the immaturity of the mothers at the time of service, the native system being to allow of service when the sheep are even so young as eight months. In consequence, the immature ewe possesses but little milk and a revulsion of feeling towards the offspring is noticed in a few cases.

The experimental work with sheep at the Isiolo African Veterinary Training Centre is in charge of Mr. H. C. W. Guy, a capable officer with training in, and practical application of sheep husbandry.

It is hoped that much reliable and interesting data will be derived from the experiments at present in hand, but more time is required to gain knowledge of the resistance to disease, and the suitability for local conditions, of the various crosses.

During 1930 the organisation of this African Veterinary Training Centre will be developed and a start made in teaching the native sheep owners of the Colony better systems and methods of sheep husbandry.

TABLE OF COMPARATIVE WEIGHTS OF EACH FLOCK.

BREED				Average age	Average weight
					<i>lb. ozs.</i>
Black Headed Persian Rams				4 teeth up	78 14
Black Headed Persian Ewes				6 "	67 8
Masai Ewes				2 "	50 15
Samburu Ewes				2 "	50 8
Gabbra Ewes				2 "	47 10
" Rams				2 "	54 4
" Control				2 "	47 8

NYANZA PROVINCE.

One Veterinary Officer and three Stock Inspectors were stationed in this Province for the whole year. Two additional stock inspectors were stationed for short periods but were invalidated out of the Province.

The Veterinary Staff stationed in the Kisumu-Londiani district gave assistance to the Lumbwa Native Reserve.

The staff within the province was distributed for duty as follows.

The Veterinary Officer and one Stock Inspector were stationed at Maseno; one Stock Inspector at Kibigori; one Stock Inspector at Alego in Central Kavirondo; and one Stock Inspector at Kitai in North Kavirondo.

Two attempts were made to establish a Veterinary Centre in Samia, but after two Stock Inspectors had been incapacitated by malaria and in the absence of any housing accommodation, the staff was withdrawn and the work supervised from Alego.

No Veterinary staff was stationed in South Kavirondo.

As recorded elsewhere, an African Veterinary Training Centre was started and developed during the year at Maseno.

Disease.

It is well known that the areas of the Nyanza Province are probably most highly infected with every tick-borne disease, and the calf mortality is well over 50 per cent from these causes alone.

It is recognised, from official tick-exposure tests, that cattle over two years of age are immune to tick-borne diseases, including East Coast Fever, with the exception of such cattle as are drawn from the slopes of Mount Elgon.

Rinderpest.

This disease has occurred in isolated outbreaks in all locations in Central Kavirondo, while in North Kavirondo the only outbreak was reported in the Marach location.

The Kavirondo natives now realise the advantages of having their stock immunised against Rinderpest and bring forward their stock willingly for inoculation.

The following table shows the numbers of animals immunised or tested for Rinderpest for the districts of North and Central Kavirondo.

NATIVE RESERVES—NYANZA PROVINCE.
RINDERPEST INOCULATIONS.

DISTRICT	RINDERPEST		Mortality	Revenue
	Double Inocu- lations	Tests		
<i>Sh. cts.</i>				
CENTRAL KAVIRONDO—				
Asembo	1,740		437	18,469 00
Kadimu	860			
Kijubu	651			
Kisumu	3,062			
Sagani	1,068			
Sakwa	915			
Seme	2,880			
South Gem	824			
Kano and Nyakatch ..	12,129	22		
Farm Stock (Kibigori) ..	494	21	311	31,968 00
Alego	5,416	..	125	17,977 00
Samia and North Nyanza	10,196	..	294	24,941 50
NORTH KAVIRONDO—				
Kitai	7,808	..	195	18,007 50
TOTAL	48,043	43	1,362	111,363 00

The total number of Rinderpest inoculations in the Central and North Kavirondo districts was 48,043 head of cattle, including 32,088 adults and 15,955 calves and in addition, forty-three tests.

The mortality from all causes was 1,362 head, or 2.8 per cent.

These figures show a satisfactory increase over the 1928 figures, which were 34,850 head of cattle double inoculated against Rinderpest, including 29,324 adults and 5,303 calves, and including 223 tests, with a mortality of 4 per cent.

Contagious Bovine Pleuro-Pneumonia.

The staff stationed within the reserve report that the incidence of this disease is becoming very light in the affected locations in Central Kavirondo, and clinical cases have not been observed throughout the year.

In the Kibigori area 1,222 pleuro-pneumonia vaccinations were carried out by request, these included 539 native owned stock and 634 farm stock.

In spite of a diligent search no evidence of this disease could be found in North Kavirondo and forty-nine native owned cattle only were vaccinated against the disease.

Blackquarter, Anthrax and Measles infection are widespread throughout the Nyanza Province.

Trypanosomiasis.

This disease is prevalent in cattle in those locations which border the Lake, and in some places contiguous to them.

The Trypanosomiasis is of the Congolense variety and affects cattle grazing or watering in the swamps.

As the natives were asking for assistance, and in view of the high percentage of infected cattle in certain locations, it was decided to undertake an experimental inoculation with antimosan and with Tartar Emetic. The treatment by this method is mentioned elsewhere in this report.

General.

The staff assisted in the locust campaign. The campaign towards the improvement of hides and skins has received a great setback in this Province owing to the deplorable prices, and as the prices of sun- and shade-dried hides are practically the same in most locations, the natives will in most cases not shade-dry the hides. The present prices ruling in the district is Sh. 17 per frasila for first grade shade-dried hides. Some of the hide-buying firms in Kisumu have suspended business as they cannot dispose of their stocks.

Periodic visits of inspection were made to the various hide drying bandas throughout the district.

In the Maragoli locations, where the hides trade is wholly in the hands of natives, all the hides are shade-dried.

In other centres the majority of hides are bought "green" by Arab and Indian traders and then sun-dried.

Dairies.

The Local Native Council Dairy at Kisaini received 88,025 lb. of milk during the year. Trained Veterinary Scouts were detailed to visit the various bomas of each supplier and instruct him how to produce cleaner milk and a decided improvement has resulted in the quality of the milk.

North and South Kavirondo produced 33,000 lb. of ghee a month during 1929 : Sh. 44,000 per month.

Ghee is being manufactured on a very extensive scale in the Asambo location, Central Kavirondo, which location alone exports as much as 12,000 lb. per month during the season.

Many separators are idle in the locations and as far as can be ascertained the reason for the stoppage is the lack of cash to pay for milk on purchase, and because the natives have to wait a long period before receiving payment for cream, butter or ghee.

Revenue.

Sh. 111,363 were paid into the local district offices for inoculation and testing fees for Central and North Kavirondo districts, as compared with Sh. 68,445/50 in 1928; Sh. 165,764/50 in 1927; and Sh. 122,176/50 in 1926; making a grand total for the past four years of Sh. 467,749/50.

During the past four years nearly 200,000 cattle have been inoculated against Rinderpest in North and Central Kavirondo districts, which represents in numbers about a quarter of the total owned by the natives in these districts.

Cinema Camera.

Stock Inspector Murray has shown enterprise and initiative in purchasing a cinema camera at his own expense, and has attracted crowds of interested natives to a show of films, depicting better types of stock and methods of animal husbandry, etc. Much useful teaching and propaganda work has been accomplished by this effective means and Mr. Murray's work in this connexion is highly commended.

Lumbwa Native Reserve.

The Lumbwa native cattle have again been swept through by Rinderpest with great loss. The successive outbreaks in this reserve may almost be looked upon as one permanent outbreak.

The same remarks apply to Contagious Bovine Pleuro-Pneumonia.

Although certain individual natives have requested the Department's assistance for an inoculation service, it is found unsatisfactory to deal piece-meal with such enormous outbreaks. With most of the natives objecting to any veterinary assistance, the difficulty of detailing staff for temporary work, of doubtful use, from the personnel of organised districts, has

proved in the past most unsatisfactory and leads to dissatisfaction and complaints from the staff and settler farming associations.

Nandi Native Reserve.

During the year a Stock Inspector was resident in the Nandi Reserve, under the control of the Veterinary Officer, Eldoret, who made periodic visits of inspection to his stations.

The two Veterinary Stations situated at Kingwal and Kaptumo were opened for certain periods during the year to give an inoculation service, at the request of the natives. The inoculations against Rinderpest were successful, except on one occasion at Kaptumo, when unusual mortality was experienced from Redwater. As the natives refused the specific treatment of inoculation with Trypanblau, heavy mortality occurred in certain mobs of cattle which might have been obviated.

The following Rinderpest inoculations and tests were carried out at the request of the natives, at the above stations.

5,998 native-owned cattle, 313 trade cattle, and 886 cattle were tested.

The total mortality was 108 head, including sixty-three from Redwater and seventeen from East Coast Fever.

Revenue paid in for inoculation fees was Sh. 16,503. In all 7,197 cattle were inoculated or tested during the year, which is the smallest number on record, although very little different from the 1927 figure of 7,552. The reason for the decrease may be the light incidence of disease in the reserve at the moment, and the natives appear to be temporarily lulled into sense of safety.

About 55,000 Nandi cattle have been inoculated against Rinderpest during the past four years, including a small number of trade stock, for which Sh. 115,934 have been paid into revenue.

This number of stock represents about 55 per cent of the Nandi cattle.

Nandi Local Native Council representatives visited Ngong during the year to study the system in use there, and were so much impressed that, on their return, the Local Council offered a magnificent area of land for the erection of a native training centre, and voted a sum of money for the purchase of heifers.

Although this gesture was accepted it is felt that the centre must take some time to develop out of Departmental votes.

MACHAKOS AKAMBA RESERVE—REDUCTION OF STOCK.

A second survey of this reserve was carried out specially to obtain some idea of the relation of stock to carrying capacity.

It is pointed out that at present overstocking is met by emigration, but no attempt is made to reduce stock to the average carrying capacity of the land. Stress is laid on the steady deterioration of the reserve and of the lack of any attempt to control the movement of stock. The sequence of events following any organised attempt to deal with the situation is reduction of stock, control of movement, conservation of water supplies, increase of the grazing areas, and finally improvement of the stock.

The Machakos Akamba partly met their difficulties in regard to the shortage of grazing by emigration into the surrounding alienated areas, and therefore the numbers of stock owned by these natives is considerably in excess of the recorded figures, as the census only included the numbers of stock within the boundaries of the reserve.

Several facts are brought to light which are worthy of note :—

1. The large percentage of male to female stock;
2. The large variation in the grazing capacity of the different parts of the reserve; and
3. The reserve is carrying .24 cattle and .3 sheep and goats per acre.

The tendency will be that the stock raised under such conditions must continue to degenerate as the hardiest stock survive the severe period of trying times with little or no food and usually these animals are poor producers.

Allowing the reserve to remain overstocked and hesitating to make some change only puts off the evil day, as the reserve and the grazing are rapidly deteriorating.

Unfortunately the male cattle can only be sold on a limited market as transport animals, because, owing to the heavy infestation of measles, there is no meat market open to them.

The cattle have good inherent milk characteristics and it is possible that educational steps of a simple nature may induce the native to consider favourably the advantages of keeping fewer cattle of a better type, as compared with his present methods. It is essential to demonstrate to the native that modern methods are more profitable.

The establishment of local markets within the reserves would only meet the small wants of the local population, as the limits of demand are determined by the standard of living.

There is a necessity, therefore, to seek a market elsewhere.

The principal factors against any success are the low standard of native ideas and methods based on a tradition of inactivity and indifference, and the inferiority of the stock.

To enable the native to employ to the best advantage his agricultural resources a commencement must be made by endeavouring to overcome his indifferent attitude by education. There is a serious lack of effective educative facilities as far as the animal industry is concerned, although several native industrial schools include elementary animal husbandry in their curriculum. A start has, however, been made at the African Veterinary Training Centre, Ngong, and elsewhere.

By demonstration it is hoped that the native will realise what better methods of animal management mean; and if his confidence can be gained and maintained, the substitution of quality for quantity should follow and thus assist in the gradual reduction of his flocks and herds.

As regards the products, quantity should follow on the quality, and it is felt that if there is a possibility of marketing these products—particularly ghee—local capital would be forthcoming to place these saleable products on the world's markets.

The overstocking of this native reserve requires immediate attention as the stock must be reduced rapidly to prevent the destruction of the grazing.

Whether it be decided or not to take action and erect factories for the conversion of carcasses into meat juices, fertilisers, fats and tallows, etc., as well as for the immediate reduction of surplus native stock, the suggestion made here would provide a means for the annual reduction of stock, by the education of the native owner and by the gaining of his confidence for the welfare of his stock.

The following summary indicates the acreage and stock population in respect of the Machakos Native Reserve. These figures are of stock actually within the reserve at the time the census was taken.

Acreage	Acreage Cultivated	Carrying Capacity	CATTLE		Sheep	Goats
			Adults	Calves		
1,065,000	32,300	53,400	188,910	57,090	50,381	260,008

Cattle proportion—Male to Female=1 in 4·7.

MASAI RESERVE.

As the Masai Reserve occupies about 9,000,000 acres of this Colony and contains approximately about 2½ million head of livestock, together with countless herds of game, it might be advantageous to state the endeavours of a Veterinary Officer, stationed in the Kajiado district of this reserve, during the last six months of the year.

No Veterinary Staff has been stationed among this pastoral tribe for several years because of its resentment to veterinary measures, particularly inoculations, from which they suffered reported losses in one instance in past years.

This reason cannot be said to be the only one, for so long as the Masai natives can find sufficient grazing for their cattle and food for themselves they assume an independent attitude and simply want to be left alone.

It was stated that confidence would be gained if a young departmental officer were sent into the Masai Reserve to learn about the people and their language. Such an officer was sent into the Masai Reserve from the Veterinary Department and after a stay in the Kajiado District for three months, he was able to produce a scheme for veterinary services for the control of disease and the marketing of Masai stock, which was agreed to by the officers of the other departments concerned, and by the natives themselves.

A certain amount of work was undertaken and much information gained about the Masai stock, but at a Native Council meeting held at Loitokitok during Christmas an attitude was taken up by the natives which has rendered all the past work in the Reserve of no avail.

This Council intimated that they did not wish any more veterinary work to be done in the reserve whatsoever, a complete and absolute reversal of opinion and outlook from that obtaining a short while previously.

Up to the present no official reason has been given for this action and in consequence all veterinary work has ceased within the reserve and the Veterinary Officer has been temporarily withdrawn, in the absence of any work for him to do except at Ngong Training Centre.

The Veterinary Officer (Mr. F. W. Aston) reports as follows: " This report covering the period between the beginning of June and the end of the year 1929, deals with veterinary work and activities which have taken place in the Kajiado district, Masai Reserve.

Condition of Reserve.

The years 1927-28 and first part of 1929 have, as far as rainfall is concerned, been bad years in most parts of the Kajiado district. This was reflected in the great shortage of grazing during 1929 when things became so bad that a condition of famine prevailed in many parts. Many cattle died from starvation and lack of water, some bomas losing as many as 75 per cent from these causes. In other areas, notably at Manga, Rinderpest occurred as a complication of the foregoing and losses were extremely heavy; in fact, some bomas were practically wiped out.

The grass was sparse and burnt and in many places soil erosion had taken place; this still continues to such an extent that it is problematical whether the grazing will ever recover under the present system of grazing. Large areas require resting for a number of years, but as this is against the habits and customs of the Masai it is probable that the grazing in these areas will not be given a chance to recover.

On the other hand certain areas exhibit excellent grazing but these are not available for the Masai as there is no water near them. Boring operations during 1929 have opened up some of these areas but others still remain.

Condition of Cattle, etc.

From the foregoing section it will easily be seen that the condition of the cattle must be bad. Those that survived the drought were for the most part the small, tough and hardy animals and now that conditions have improved these are the

animals from which future generations must come. The Masai appear to realize this and are buying heifers from the Wakamba Reserve.

Disease.

Rinderpest would appear to be quiet at present, though several outbreaks occurred during the year, the worst and largest being at Manga, when the mortality was enormous.

Bovine Pleuro-pneumonia is still present, notably among the Kaputei Masai who went to Ngong for grazing during the drought. These bonas have also imported East Coast Fever from Ngong, this disease is at present almost wholly confined to the young stock. *Pleuro-pneumonia* would appear to be spreading as it is now down the Magadi line near Turoka, as well as among the Kaputei. Tick-borne diseases other than East Coast Fever appear to be uncommon, as I have been unable to find any definite cases of Redwater or *Anaplasmosis* up to the present time.

The disease *Ngati*, with which I first came into contact near Athi River in June, 1929, would appear to be identical with *Snotziekte*. The Masai aver that the spread of *Ngati* can take place not only from the place where a wildebeest has dropped her calf, but also from the sleeping places or tracks of large snakes, whether this is true or not I am unable to say.

M'benete, a name which embraces diseases as widely apart as Anthrax and Contagious Abortion appears to denote a specific disease, at least in the Laitokitok area, if not in others. Water coming down from the mountain (Kilimanjaro) at certain seasons and passing over various fallen leaves en route is said to cause *M'benete*. Cold, also, is said to cause the disease when the animals are in bad condition. The symptoms, briefly stated, are as follows: Weakness, staggering gait, good appetite, laboured breathing, no cough, ropey mucous discharge from nostrils, eyes sunken but quite bright, no mouth lesions. The lungs on post mortem are oedematous but do not show the typical *Pleuro-pneumonia* appearances. The disease is not infectious, isolated cases only occurring in a herd and showing no tendency to spread.

Veterinary Work, 1929.

Every advantage was taken of the close contact with the Masai, which my veterinary surveys entailed, to talk with them of the advantages of quarantining, inoculation and the

improvement and reduction of their stock. They showed an intelligent interest, especially in the case of quarantining of infected herds; they were distrustful of inoculations as they were under the impression that the material used for their cattle would be inferior to that used for other people. As for reduction and improvement of their stock, they quite rightly pointed out that famine had already reduced them and that they would talk about improvement when conditions became more normal and when there was grass to support the stock when improved.

A *baraza* was held at Manga on 31st October, 1929, the Chief Veterinary Officer and the District Commissioner, Kajiado, being present. The condition of the cattle and the progress of the disease precluded any vaccination at that particular time, but certain Masai agreed to have inoculations done in any subsequent outbreaks that might occur. Kimuruai, brother of Segi, the paramount chief, even intimated that he would like his cattle done as a preventive measure when they had picked up in condition. The *baraza* agreed to report disease and to submit to quarantine measures.

On 9th November, 1929, I proceeded to Laitokitok to find a suitable boundary between the Laitokitok Masai and the Matapatu and Kaputei. The intention was to have this boundary guarded by scouts and so keep the Laitokitok district, which is singularly free from both Rinderpest and Pleuro-pneumonia, clear from outside infections. The ultimate aim was to lift the official Masai Reserve quarantine from this area, so that trade with Tanganyika might take place. The boundary was chosen and five Moran taken on as guards, under the control of a trained Veterinary Scout from Ngong. This arrangement met with the approval of all the Masai concerned.

Unfortunately, after a month's quarantining, the guards had to be discharged owing to the complete reversal of opinion among the Masai with regard to Veterinary Services in the reserve."

KERIO PROVINCE.

A veterinary staff, under Veterinary Inspector Hassan, was stationed in the Kamasia, Njemps and East Suk Reserves.

Rinderpest.

Extensive inoculations against Rinderpest were carried out at three centres and included the task of repatriating Uasin Gishu Masai. In all 14,383 cattle were dealt with, including

7,630 inoculations and 6,753 tests for immunity. Every animal which was double inoculated also received an immunity test, and in spite of a big percentage of susceptible animals, the mortality was trivial. As the stock graze in the Kerio Valley during the periods of dry, short grazing, a fair percentage of cattle were apparently affected with Trypanosomiasis, and in consequence the blood of the virus-makers was treated with Antimony Tartrate solution, before use.

Mortality is reported among the stock only inoculated with blood, as a test for Rinderpest immunity.

It should be recorded that during the past two years over 40,000 cattle have been double-inoculated against Rinderpest in the Njemps and Kamasia Native Reserves with a mortality from all causes of 121 head.

Bovine Pleuro-pneumonia.

2,100 cattle were vaccinated during the year and a review of the diseases in native reserves is referred to elsewhere in the report.

These native reserves are largely overstocked and the natives possess a large number of unproductive and useless cattle, sheep and goats. The pastures are in a deplorable condition. Many areas are covered with dense bush and the best grazing is found in the swamps. Other grazing areas, covered with a thin sprinkling of bush, are so overstocked that the grass is generally eaten off before it has a chance to seed or produce any undergrowth.

A compulsory cutting campaign of useless stock is indicated for the benefit of the cattle and the land.

OTHER NATIVE RESERVES.

It is regretted that no veterinary staff were available for several native reserves during the year, but provision is made to give a veterinary service in the Coast Province during 1930.

NATIVE RESERVES—NORTHERN FRONTIER PROVINCE.

Contagious Bovine Pleuro-pneumonia.

Contagious Bovine Pleuro-pneumonia is still prevalent in the Northern Frontier Province, as the infection is kept going by the unregulated movement of stock within the Province, for trade and other purposes.

As the result of the movement of infected stolen stock from the Lumbwa district, back to the owners in the East Suk reserve, an outbreak of the disease occurred among the Suk stock.

Three outbreaks were officially reported among the Ndigiri and Mukogudu cattle; these outbreaks were successfully handled by slaughter and segregation of infected animals and the vaccination of incontacts.

The outbreak was a severe one, as fifty-two head died out of a total of 242 in the three infected mobs.

In all 5,425 cattle were vaccinated three times, the first and second vaccinations were given in the tail at intervals of a fortnight, with a final vaccination behind the shoulder.

The reactions were severe and in spite of careful control, thirty-nine deaths are recorded as the result of vaccination, thirty-seven deaths following the first vaccination and two deaths after the second vaccination.

376 adults and 402 calves failed to react to any of the vaccinations.

RIFT VALLEY PROVINCE—EAST SUK.

Njemps and Kamasia Native Reserve.

The cattle grazing in the Churo extension area were found to be infected as already reported and it was decided to move the stock back to within the boundaries of their reserves with a Stock Inspector in charge, to segregate and vaccinate the herds.

The infected herds are now in quarantine and number 470 head, the mortality up to date being 161. At the end of the year this mob had been vaccinated once only. Preparations are in hand to vaccinate the segregated incontact herds numbering approximately 20,000 head. In spite of a close survey no Pleuro-pneumonia could be found in the Suk Reserve, previous to the reported outbreak.

A number of Kamasia native stock was found among the Suk cattle on the Churo extension areas and over a thousand head were repatriated to their reserve, after immunisation against pleuro-pneumonia.

In view of the two outbreaks of Pleuro-pneumonia in the native stock on farms in the Eldoret district it is considered that this disease is existent only in isolated centres in this Province, particularly in stock near the Forest Concessions.

KISUMU PROVINCE

The district staff stationed in Central and North Kavirato were unable to trace any Pleuro-pneumonia in bovines in these districts. It will be remembered that all movement of stock from the Central Kavirato Native Reserves was prohibited for some years because of the prevalence of this disease. Many thousands of ruminants, which have been carried out free on the stock of this district, have had a successful issue. The survey of the reserve is to be repeated, and the meat markets are to be watched for evidence of this disease.

The following figures show the number of cases of Pleuro-pneumonia among slaughter stock exported to Uganda via Kisumu.

	1921	1922	1927	1928-9
Cases	Nil	4	15	Nil

The following animals were exported to Uganda via Kisumu:—

CATTLE		SHEEP AND GOATS		PIGS	
1928	1929	1928	1929	1928	1929
666	1,586	433	782	..	64

The Lumbwa Native Reserve is reported to be badly infected with Pleuro-pneumonia, and the natives are again asking for assistance; unfortunately, the task is of a magnitude beyond the resources of the Veterinary Officer and his staff, resident in the neighbouring settled areas.

MASAI PROVINCE.

As the result of the Veterinary Survey in the Kajiado district, pleuro-pneumonia in bovines was found to be widely spread in the Kaputei section.

HIDES AND SKINS.

The better preparation of hides and skins has received much attention by various Government Departments and public bodies, with the object of establishing a better name in the world's market for "Mombasa" hides and skins.

The natives, who would benefit financially by a higher price for an improved article, seem to be very apathetic at the present time in this respect and, generally speaking, do not show any keenness in the production of better prepared hides and skins.

It has been suggested that the schemes proposed by Government for the better preparation of hides and skins have been altogether too ambitious, and have fallen through on that account. The schemes have failed or succeeded in accordance with the fall and rise of market prices, this has strained the feelings between the buyers and sellers, and although uneducated in many respects, the native seller is astute enough when concerned in the trading of his goods.

The present method adopted for the better preparation of hides is very simple and easily acquired by the native, with the result that hide drying centres have been established in many parts of the Colony, chiefly at the request of the natives.

The inception of the scheme at first met with difficulties, as the natives objected to the extra amount of work entailed in the better preparation and shade drying, but the high market price for hides in 1926 and 1927, especially the better prepared hides, evinced in them the keenest interest.

Illustrated articles and a pamphlet were published, giving details of the methods of preparation and of the building of drying *bandas*.

Certain commercial firms gave a small premium for hides and skins which were well prepared, in order to encourage the native seller in his efforts.

Complaints that the middlemen and native buying agents were receiving additional profits were made in May, 1927, and it was thought that the natives were not obtaining a full market price.

Suggestions have been made to control the buyers by means of a system of grading of the hides and skins, publication of market prices, the establishment of controlled markets, a system of punishment for the faking of hides, and the licensing of itinerant buyers, but as yet no real steps have been taken to deal with the situation as a whole.

The present position is : the natives, except in instances near big stock markets, will not undertake, or show any inclination towards the better preparation of hides and skins, for the following reasons :—

1. Greatly reduced market price of hides and skins.
2. The natives have no knowledge of market prices and should be given means of knowing them.
3. The itinerant trader does not grade the hides, but buys them in lots, irrespective of variations in quality.
4. Except in rare cases, the native does not secure a higher price for the better prepared article.

It does appear, therefore, that the natives in this Colony have a knowledge of the ways and means to prepare hides and skins for market, but are indiffererent towards these activities because of the difficulties of trading.

Reference could be appropriately made to the branding of hides, which causes the worst defects, by stating how impossible it would be at the moment to stop natives branding their cattle.

The Brands Ordinance defines that animals should be branded only on the neck, forearm, shank, etc., and the size of the brand mark to be used, leaving the back, sides and quarter, which form the " square " of the hide, entirely free from brands.

The native uses various forms of branding as a means of identification, as a curative form of treatment against disease, and as a tattoo mark to mark the beast with *maridadi*.

To bring pressure on the native stock owner in order to check indiscriminate branding will be very difficult and must take the form of persuasion, with a great exercise of patience over a long period.

The native will use the hot iron in cases of disease because he has faith in this remedy, and he will inform you that he prefers a spoiled hide to a dead animal.

The other reasons for the indiscriminate branding might, in my opinion, be remedied, but unfortunately the branding for many diseases affecting stock in native reserves is the most common reason for the brand marking of hides and skins.

In the Kamasia, N'jemps and East Suk Native Reserves, the officer in charge (Veterinary Inspector Hassan Shah), opened up camps in which over sixty hawkers received practical demonstrations and were granted efficiency certificates.

It is understood that during the latter part of the year the improvement of the hides and skins from these native reserves was most satisfactory, and that hides from those sources were in comparatively greater demand.

The majority of hawkers trading between natives and middlemen are mostly uneducated natives, carrying on business with little capital or with borrowed money, but the present system of buying *shella bella* hides and skins creates a great deal of uneasiness in the minds of the natives, with an inevitable result.

A trained staff of native scouts are stationed in certain markets in these reserves to supervise the preparation of hides and skins.

REVENUE.

The total amount of revenue collected during the year 1929 was Sh. 425,571/64, which shows an increase of Sh. 88,031/64 over 1928.

Of the total revenue of Sh. 425,571/64, the sum of Sh. 240,030/83 was derived from settled areas and Rinderpest service, which included a large number of squatter cattle; Sh. 185,540/81 from native reserves and veterinary quarantine stations. These figures show an increase for settled areas (including Rinderpest service) of Sh. 56,354/93 over 1928, and an increase of Sh. 31,673/71 for native reserves.

The revenue of this Department is principally derived from inoculation services, rendered at scheduled prices when required to eradicate outbreaks of contagious disease, or as a result of a request for an immunisation process from any stock owner. There are other minor sources of revenue, such as sheep dipping fees, quarantine fees at Mombasa Island, quarantine fees on imported animals from overseas, etc.

The greater part of the revenue is based on the existence of animal disease, and the voluntary request of owners of stock for protection from disease, by immunisation.

It is impossible to foretell outbreaks of disease, or to foresee the number of requests for a protective service, and in consequence the amount of revenue must be purely approximate.

Future revenue cannot be gauged on figures of the past nor on the present year, except in the case of a general increase or decrease, it is difficult, almost impossible, to estimate the figure with any accuracy.

The increase of the revenue from the settled areas is mostly due to the activities of the Rinderpest service. This service has now inoculated all the big stock in the settled areas, and in future only the annual increase of stock will be treated. In consequence a considerable decrease must be expected in revenue from this source.

Occasionally a district revenue may show an increase through an appearance of diseases, causing, as in 1929, an unexpected activity for preventative or curative measures.

The details of the revenue and expenditure are shown below.

SUMMARY OF EXPENDITURE, 1929.
VETERINARY DIVISION.

	Original Estimate Sanctioned	Actual Expendi- ture	Excess	Savings
	£	£	£	£
HEADQUARTERS AND FIELD STAFF.				
Personal Emoluments	26,460	25,270	..	1,190
Labour	5,400	5,195	..	205
Medicines and Instruments ..	600	518	..	82
Maintenance of Veterinary Stations	2,500	2,320	..	180
Maintenance of Veterinary Dips	800	780	..	20
Compensation payable under Diseases of Animals Ordina- nce	150	..	..	150
Horse Allowance	72	3	..	69
Purchase of Animals and Equip- ment	450	404	..	46
Incidentals	830	823	..	7
Purchase of Brands	170	156	..	14
Passages	1,550	1,563	13	..
Travelling Allowances	1,500	1,253	..	247
Local Transport and Travelling	9,370	9,180	..	190
Carriage of Goods	750	835	85	..
Library Books and Periodicals	200	170	..	30
CENTRAL NATIVE TRAINING CENTRE.				
Personal Emoluments	1,558	1,254	..	304
Labour	1,400	1,357	..	43
Medicines and Instruments ..	100	88	..	12
Expenses of Instruction	600	590	..	10
Maintenance of Station	600	558	..	42
£	55,060	52,317	98	2,841

COMPARATIVE STATEMENTS OF EXPENDITURE AND
REVENUE FOR THE YEARS 1924 TO 1929 INCLUSIVE.

VETERINARY DIVISION.

	1924	1925	1926	1927	1928	1929
	£	£	£	£	£	£
Expenditure (actual) ..	29,546	37,026	38,627	41,890	48,852	52,317
Revenue (actual)	11,536	24,520	25,320	22,400	16,877	21,279
Expenditure (after deducting Revenue) ..	18,010	12,506	13,307	19,490	31,975	31,038

VETERINARY RESEARCH DIVISION.

	1924	1925	1926	1927	1928	1929
	£	£	£	£	£	£
Expenditure (actual) ..	20,600	27,743	29,686	29,888	30,332	38,161
Revenue (actual)	7,328	6,543	4,712	5,174	10,830	18,145
Expenditure (after deducting Revenue) ..	13,272	12,020	24,974	24,714	19,502	20,016

TOTAL EXPENDITURE, VETERINARY SERVICES, FOR THE
YEARS 1924 TO 1929, AFTER THE DEDUCTION OF REVENUE.

1924	..	..	..	£	31,282
1925	..	..	..		33,706
1926	..	..	..		38,281
1927	..	..	..		44,024
1928	..	..	..		51,477
1929	..	..	..		51,054
				£	<u>249,824</u>

COMPARATIVE STATEMENT OF REVENUE FOR THE YEARS
1926-27-28-29.

STATION	1926	1927	1928	1929	Total for four years
	<i>Shs. cts.</i>	<i>Shs. cts.</i>	<i>Shs. cts.</i>	<i>Shs. cts.</i>	<i>Shs. cts.</i>
SETTLED AREAS.					
Machakos	18,575 00	18,575 00	18,575 00	18,575 00	18,575 00
Nakuru	6,575 06	3,253 70	8,422 75	4,459 38	22,710 89
Naivasha	420 36	.. ..	.. ..	.. ..	420 36
Nan yuki	34,206 10	62,466 18	1,515 15	4,521 15	102,708 58
Lumbwa	1,916 50	2,274 00	5,090 40	50,401 70	59,682 60
Eldoret	1,034 50	806 80	3,297 60	.. ..	5,138 90
Nairob	15,335 90	17,527 00	18,323 55	55,484 45	106,670 90
Kitale	328 00	530 00	146 00	635 50	1,639 50
Rumuruti	1,970 48	.. ..	.. ..	.. ..	1,970 48
Gilgil .. ..	.. ..	1,193 45	11,278 45	2,820 65	15,292 55
TOTAL ..	61,786 90	88,051 13	48,073 90	136,897 83	334,809 76
Rinderpest Service	60,264 50	60,478 50	135,602 00	103,133 00	359,478 00
QUARANTINE STATIONS AND NATIVE RESERVES.					
Mombasa	16,046 96	23,254 60	19,217 50	19,617 66	78,136 72
Eldama Ravine ..	164 40	.. ..	.. ..	.. ..	164 40
Isiolo	9,083 31	980 50	7,254 00	3,796 15	21,113 96
Kibigori	27,910 50	9,629 00	11,718 00	31,968 00	81,225 50
Machakos	30,451 96	12,952 50	7,604 00	8,052 50	59,060 96
Waterfalls	39,288 00	11,166 50	.. ..	5,048 00	55,502 50
Kitai & Bungoma	94,266 00	142,800 50	36,149 50	18,077 50	291,223 50
Kingwal	60,594 50	16,631 50	20,103 60	16,468 00	113,797 60
Timboroa	51,620 50	.. ..	25,583 00	20,776 00	97,979 50
Ngong	216 00	.. ..	.. ..	403 50	619 50
Sondu .. ..	.. ..	6,781 00	4,235 50	16 00	11,032 50
Kaptumo .. ..	.. ..	2,101 50	.. ..	.. ..	2,101 50
Kilungu, Mbooni and Sultan Hamud .. ..	.. ..	46,526 50	.. ..	.. ..	46,526 50
Kamasia .. ..	.. ..	15,391 00	1,421 00	.. ..	16,812 00
Kakunga .. ..	.. ..	5,117 00	.. ..	.. ..	5,117 00
Chebororwa .. ..	.. ..	6,117 00	6,161 00	.. ..	12,278 00
Kisumu .. ..	.. ..	.. ..	14,417 00	.. ..	14,417 00
Alego .. ..	.. ..	.. ..	.. ..	17,977 00	17,977 00
Samia .. ..	.. ..	.. ..	.. ..	24,941 50	24,941 50
Maseno .. ..	.. ..	.. ..	.. ..	18,469 00	18,469 00
Ukamba (Rinder- pest Service) ..	54,718 54	.. ..	.. ..	.. ..	54,718 54
TOTAL S%.	384,360 67	299,449 10	153,864 10	185,540 81	1,023,214 68
TOTAL REVENUE, ALL SOURCES.					
Settled Areas ..	61,786 90	88,051 13	48,073 90	136,897 83	334,809 76
Rinderpest Service	60,264 50	60,478 50	135,602 00	103,133 00	359,478 00
Native Reserves ..	384,412 07	299,449 10	153,864 10	185,540 81	1,023,214 68
GRAND TOTAL S%	506,412 07	447,978 73	337,540 00	425,571 64	1,717,502 44

GAME AS SPREADERS OF DISEASE.

Many of the game species are susceptible to some of the infectious diseases of the large domesticated animals.

The spread of disease through the agency of game varies with the nature of the disease and in the manner in which both wild and domesticated animals are attacked; the dissemination of acute diseases, such as Anthrax, is negligible,

but on the other hand diseases such as Rinderpest and Swine Fever, which run a less acute course, undoubtedly are spread through the agency of game.

There is yet another manner in which game animals may be responsible for the maintenance and spread of contagious diseases, i.e. where the game animal is better adapted than the domestic animal to parasitisation by the pathogenic agent. Examples of this relationship are found in some of the Trypanosomiasis, and there is a very striking example in the so-called " Snotziekte " of wildebeeste, which is caused by a filtrable virus extremely pathogenic to cattle, but apparently harmless to the reservoir animal, the wildebeeste.

The most serious handicap to stock rearing in Kenya is East Coast Fever, a disease transmitted by ticks. There is experimental evidence to show that a tick infected with the East Coast Fever parasite cleanses itself by feeding on an insusceptible animal, and since we have no definite knowledge that any of the large game are susceptible to East Coast Fever, they are blameless in this respect.

Ticks can, however, be transported considerable distances on a host, without actually attaching and feeding, and infected ticks may in this manner be carried for considerable distances, finally being brushed off by bush or grass, without ever having fed.

The control of East Coast Fever must depend upon eradication of certain tick groups, which is impossible in the presence of large numbers of game animals, most of which have already inculcated as hosts of these ticks.

In the meantime large herds of game, by breaking down fences and entering an infected farm, can render almost impossible the task of a stock farmer who is endeavouring to control East Coast Fever in his herds by fencing and dipping.

Two other diseases might be mentioned, Heartwater of sheep and cattle, and Rabies.

Heartwater is a disease of rapidly increasing importance in Kenya, and if an analogy is drawn from other similar diseases, it appears probable that a reservoir for the virus of Heartwater will be found in certain wild animals, which serve normally as hosts of the larval and nymphal stages of the vecting tick. Up to the present there is no knowledge of what animals act as hosts for these stages of the tick, but an extensive tick survey should succeed in elucidating the point.

The existence of Rabies has been recently diagnosed in Kenya near its northern border, and there can be no doubt that small carnivora are likely to play an important part in spreading this disease.

The preservation of valuable species is desirable, but it is evident that they should not be allowed to mix with domestic animals and man, in the presence of inter-communicable diseases, owing to the inability of controlling the course of epizootics in game animals.

MOVEMENTS OF STOCK.

During the year under review the undermentioned movements of large herds of native stock were made under the supervision of departmental officers.

1. *Movement of Squatter owned Stock from the Settled Areas of the Molo Area to the Lumbwa Native Reserve.*

This movement has been the subject of considerable discussion by settlers in the district. The continued spread of disease by the illicit movements of squatter owned stock was the original cause of the move. Opportunities were afforded to the native owners to dispose of their non-immune stock but they refused to sell in spite of many requests. All the cattle to be moved were double inoculated against Rinderpest.

On the 7th July, 1929, the movement was commenced and the route followed the main roads. The movement, involving 9,000 head of cattle, was completed on the 10th July, 1929.

2. *Movement of Masai owned Cattle from the Settled Areas of the Laikipia District to the Masai Native Reserve.*

During the months of August and September, 1929, the cattle to be moved were vaccinated against Rinderpest and Pleuro-pneumonia. On the completion of the vaccinations, the cattle were assembled at Nanyuki and dipped. The cattle then proceeded to Narro Moru from whence they were entrained and railed to Athi River Station and from there were driven into the Masai Reserve.

The total number of cattle concerned in this movement was 458 head. The movement was completed by the end of September, 1929.

3. *Movement of Uasin Gishu Masai Stock from Timboroa to the Masai Reserve.*

This movement was in respect of stock owned by Masai who had been resident as squatters on alienated farms in the Uasin Gishu district.

The cattle involved were collected at Timboroa Veterinary Station, double inoculated against Rinderpest and vaccinated against Pleuro-pneumonia.

The movement commenced from Timboroa on the 17th September, 1929. The route followed was via Londiani, Lumbwa, Kericho and Sotik to Amala Bridge, at the last-named place the stock were handed over to the Assistant District Commissioner, Narok, on the 29th September, 1929.

The number of stock involved in this movement was as follows : Cattle, 6,668 head ; sheep and goats, 1,717 head.

In addition to the above-mentioned movements it is encouraging to record that other large numbers of native-owned stock have been repatriated to the native reserve from alienated stock raising districts by private arrangement.

DISEASES OF ANIMALS ORDINANCE.

Several amendments were made to the Rules of the Diseases of Animals Ordinance during the year. The most important amendment was the revision of the Rule governing the movement of cattle, under a dipping certificate.

Opinions have been expressed that the system of allowing the movement of dipped cattle from a clean area, through a dirty area, to a clean area, without the application of more stringent regulations, is fraught with danger and may be the cause of a spread of East Coast Fever infection.

Amendments of the Rules were adopted and approved, with the object of giving greater discretion to District Veterinary Officers.

1. To lengthen the period of dipping beyond the period of two months.
2. That cattle moving under a dipping permit, which travel from a dipped farm, through an infected farm, on to a clean farm, shall on arrival be dealt with in regard to dipping and isolation, as the District Veterinary Officer now considers advisable.
3. The District Veterinary Officer may now refuse absolutely to issue a permit for movement, in view of the heavy incidence of East Coast Fever on some farms, as the old discretionary powers were liable to be misunderstood and any owner of stock may consider he had the right to obtain a permit.

PERMIT SYSTEM.

The Chief Veterinary Officer and staff of the Department wish to thank the Hon. Permit Issuers for their assistance and co-operation throughout the year.

BRANDS.

The following particulars are shown in respect of the registration of brands, during the year :—

Brands registered, private ..	112	| “ S ” Brands supplied to private		
Brands registered, Government	1		individuals.. ..	48
Brands transferred	4		Set of numerals	5
Brands cancelled	1			

DISTRIBUTION OF VETERINARY STAFF AT 31/12/29.

SETTLED AREAS.

Nairobi.

Major H. H. Brassey-Edwards,
Chief Veterinary Officer.
Capt. J. T. C. Bradshaw, Ag. D.
Chief Veterinary Officer.
V. O. McKay; S. I. Harris, Dis-
trict duties, partly Native Re-
serve.
S. I. Paxton, Temporary, Quar-
antine Station.

Eldoret.

V.O. Hale (partly Native Reserve).
S.I. Smith (partly Native Reserve).

Kitale.

S.I. Jolley.

Lumbwa.

V.O. Emerson (partly Native Re-
serve).
S.I. Ward (partly Native Reserve).

Naivasha and Gilgil.

V.O. Creery.
S.I. Alcock.
S.I. Cowen.

Nakuru.

S.I. Thorne.

Nanyuki.

V.O. Danks (partly Native Reserve).

Rumuruti.

S.I. Norman.

Rinderpest Service.

V.O. Fotheringham.
V.O. Hay-Barclay.
S.I. Denwett.
S.I. Fitzgerald.
S.I. Cameron.
S.I. Wyarit.

Mombasa.

Vet. Asst. Rahman Khan.

NATIVE RESERVE.

Nandi.

Kingwal—S.I. O'Hara.

Central Kavirondo.

Maseno—V.O. McClure.
Alego—S.I. Henderson.
Kibigori—S.I. White.
Maseno—S.I. Lambie.

North Kavirondo.

Kitai—S.I. Murray.

Northern Frontier Province.

S.I. Evans (Temporary).
Isiolo—S.I. Guy.

Masai Reserve.

Ngong—V.O. Scott-Little.
S.I. Anderson.
Kajiado—V.O. Aston

Ukamba Province

Machakos—V O. Macpherson
(partly Settled Areas).
S.I. Greig (partly Settled Areas).
S.I. Low (partly Settled Areas).
Waterfalls—S.I. Glover (partly
Settled Areas).

Kerio Province.

S.I. Campbell.
Vet. Asst. Abdul Ghani.

On Leave.

S.V.O. Dixon.
S.V.O. Wheeler.
V.O. Mulligan returned from leave
28-12-29.
V.O. Beaumont.
S.I. Lewis.
S.I. O'Meagher.
S.I. Poolman.
S.I. Cassidy.
V.Inspec. Hassan.

APPENDIX D.

ANNUAL REPORT OF THE CHIEF VETERINARY
RESEARCH OFFICER, 1929.

I have the honour to submit the following Report upon the work of this Division for the above-mentioned period —

(A) ADMINISTRATIVE ACTIVITIES.

*Staff Movements.**Leave.*

The following officers proceeded on leave during the year :—

Mr. J. Walker, Chief Veterinary Research Officer.

Mr. J. R. Hudson, Veterinary Research Officer.

Mr. A. Walker, Laboratory Superintendent.

Mr. H. J. Gray, Laboratory Assistant.

Mr. F. Lyons, Laboratory Assistant.

Mr. J. Forsyth, Laboratory Assistant.

The following returned from leave :—

Mr. J. Walker, Chief Veterinary Research Officer.

Mr. A. Walker, Laboratory Superintendent.

Mr. J. R. McQueen, Laboratory Assistant.

Mr. F. Lyons, Laboratory Assistant.

Mr. J. Forsyth, Laboratory Assistant.

Appointments.

Mr. D. Dewar was appointed Librarian with effect from April 1st, 1929.

Mr. R. S. Clark was appointed Stockman with effect from May 21st, 1929.

Mr. L. O. Johnes was appointed temporary Clerk with effect from November 14th, 1929.

Mr. W. P. Langridge was appointed Laboratory Student with effect from March 13th, 1929.

Mr. D. G. Plant was appointed Laboratory Student with effect from March 18th, 1929.

Correspondence.

3,134 inward and 2,804 outward letters and telegrams were dealt with during the year, a total of 5,938. This is exclusive of communications received and despatched in connection with slides and specimens submitted for diagnosis. 6,330 such slides and specimens were received and registered during the year, and reports on same typed and despatched.

A classification of these reports is shown further on in this Report under the heading "Technical Routine."

Laboratory Farm.

The following crops were grown as foodstuffs for Laboratory animals :—

			acres
Green Maize	...	...	55
Oat Hay	...	...	30
Sunflower	...	...	20
Total			105

In addition to farming operations the farm labour was employed during the year on maintenance and upkeep of Laboratory roads, fences and grazing lands, quarrying stone for roads and concrete, preparation of ensilage, and the transport of fuel, foodstuffs and other stores from Nairobi and from Kabete Railway Station.

The number of calves born of the special breeding herd maintained at the Laboratory Farm was :—

Bull calves	...	...	21
Heifer calves...	...	...	40
Total			61

*Buildings and Plant.**Buildings.*

Five staff bungalows, commenced in 1928, were completed during 1929.

Additional accommodation for animals used for the production of Redwater-Gallsickness vaccine was erected.

Work commenced on new quarters for African employees.

The above work was carried out by the Native Industrial Training Depot in conjunction with the Public Works Department.

The erection of several minor buildings and the majority of the repair and maintenance of existing buildings was carried out by the Laboratory Workshops Staff under the supervision of our mechanic.

Plant and Apparatus.

The steam and gas plants were in daily use throughout the year.

New items of apparatus installed included :—

An electric centrifuge.

An electric pulping machine.

An electric vacuum bath.

A shaking machine.

Four electric hot plates.

Water Supply.

An electrically driven deep well pump was installed at the borehole put down by the Public Works Department in 1928, and the old mule driven pump at the "swamp" water supply was replaced by a new electrically driven vertical triple pump.

Various alterations and improvements were effected in the storage tanks and distribution pipes, and this was the first year since the inception of the Laboratory that an ample water supply for all purposes was available throughout the whole year.

Fencing.

Some 4,000 yards of the old type of wooden post and wire fencing were dismantled and replaced with new wire, iron standards and droppers, and cedar corner and straining posts.

Workshops.

In addition to the foregoing, the workshops staff, under the supervision of the mechanic, was employed on repairs to transport vehicles, farm implements, the manufacture of serum and other packing cases and various appliances for Laboratory use.

FINANCE.

Expenditure.

The total amount sanctioned for the 1929 Expenditure Estimates was £32,294, and the actual amount spent was £38,160.

The excess expenditure was incurred in meeting heavy and unanticipated demands from the Uganda Government for Anti-Rinderpest Serum, and was more than covered by the additional revenue accruing therefrom.

Revenue.

Revenue accruing directly to the Laboratory from the sale of Laboratory products totalled £18,145. Of this amount £16,782 was in respect of sales to other Governments. This is exclusive of revenue derived from rinderpest inoculations by the field staff, such revenue being shown under "Veterinary Inoculation Fees." The value of anti-rinderpest serum issued to the field staff for inoculations was £25,077.

The sale of surplus livestock realised £144.

LIVESTOCK.

The following statement shows the number of livestock, other than small animals and poultry, dealt with during the year.

SPECIES				On books 1-1-29	Increases	Decreases	On hand 31-12-29
Horses	..	..	..	20	68	28	60
Mules	..	..	..	28	1	2	27
Donkeys	..	..	..	..	1	1	..
Cattle	..	..	..	710	1,981	1,453	1,238
Sheep	..	..	..	48	195	166	77
Goats	..	..	..	6	7	13	..
Pigs	..	..	..	20	76	43	53

Details of increases and decreases are as follows:—

HORSES.

Increases—

Purchases for horse-sickness experiments	..	..	..	38
Received for experimental treatment and experiments into horse-sickness	..	..	..	28
Born at Laboratory	..	..	..	2
TOTAL	..	..	..	68

Decreases—

Returned to owners after experimental treatment	..	..	..	7
Died	..	..	..	21
TOTAL	..	..	..	28

MULES.

Increases—

Received for experimental treatment	..	..	..	..	1
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Decreases—

Died	..	..	..	..	2
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DONKEYS.

Increases—

Received for experimental treatment	..	..	..	..	1
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Decreases—

Died	..	..	..	..	1
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CATTLE.

Born at Laboratory	..	..	..	..	94
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Purchases for Rinderpest Serum Production and experimental work	..	..	..	..	1,671
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Received for experimental treatment, etc.	..	..	..	..	127
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Transferred from Veterinary Training Depot, Ngong	..	..	..	..	89
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TOTAL	..	1,981
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Decreases—

Deaths including animals killed for Rinderpest Virus Production and post-mortem examination	..	..	..	..	1,097
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Returned to owners after experimental treatment	..	..	..	..	131
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Issued to Veterinary Field Stations for Rinderpest Virus Production	..	..	..	..	202
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Transferred to Veterinary Training Depot, Ngong	..	..	..	..	17
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Sold for slaughter	..	..	..	..	6
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TOTAL	..	1,453
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SHEEP.

Increases—

Born at Laboratory	..	..	..	..	38
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Purchases for experimental purposes and Vaccine Production	..	..	..	..	89
--	----	----	----	----	----

Received for experimental work and treatment	..	..	..	..	68
--	----	----	----	----	----

TOTAL	..	195
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Decreases—

Deaths, including animals killed for Vaccine Production and post-mortem examination	..	..	..	..	154
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Issued to Veterinary Field Stations	..	..	..	..	11
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Exchanged for Caprine	..	..	..	..	1
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TOTAL	..	166
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GOATS.

Increases—

Purchases for experimental purposes	..	..	..	..	1
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Received for experimental treatment	..	..	..	..	5
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Exchanged for Ovine	..	..	..	..	1
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TOTAL	..	7
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GOATS.—*Contd.**Decreases—*

Deaths, including animals slaughtered for post-mortem examination	10
Returned to owners after experimental treatment	3
TOTAL ..	13

PIGS.

Increases—

Born at Laboratory	43
Received for experimental work	3
Purchases for experimental purposes	30
TOTAL ..	76

Decreases—

Deaths, including animals slaughtered for post-mortem examination	43
TOTAL ..	43

In addition to above, some 150 cattle were purchased at outstations by the field staff for Rinderpest virus production. These animals were taken on charge by the officers concerned, but the cost of purchase—approximately £330—was met from Laboratory votes.

The immunization of Rhode Island Red Cocks against Fowl Typhoid (Kikuyu Fowl Disease) and Fowl Pox, prior to issue to native reserves, was continued during 1929. The total number of birds so dealt with during the year was 492.

TECHNICAL ROUTINE.

The number of slides and specimens submitted for diagnosis totalled 6,330.

These comprised :—

Bovines	5,932
Equines (horses)	66
„ (mules)	16
Ovines	116
Porcines	22
Caprines	4
Canines	39
Avians (fowls)	107
„ (turkeys)	12
„ (ducks)	2
Felines	2
Various	12
TOTAL	6,330

The classification of the diagnosis arrived at is as follows:—

BOVINES	Total examined	5,932
Abortion	1	
Actinomycosis	2	
Anaplasmosis	90	
Anaplasmosis (suspicious)	3	
Anthrax	30	
Ascaris	1	
Bacillus necrosis	2	
Blackquarter	13	
Contagious Abortion	123	
Contagious Abortion (doubtful and suspicious)	33	
Colon bacillosis	18	
East Coast Fever	620	
East Coast Fever (doubtful and suspicious)	4	
Fluke (distoma)	1	
Gastro-enteritis	1	
Heartwater	3	
Heartwater (doubtful)	1	
Mastitis	1	
Nephritis	1	
Plant poisoning (suspected)	6	
Pleuro-pneumonia	1	
Proteus Infection	1	
Redwater	253	
Rinderpest	1	
Small Piroplasms	131	
Sarcocysts	1	
Streptothricosis	4	
Trypanosomiasis	97	
Tuberculosis	2	
Unsuitable for examination	170	
Negative	4,317	
EQUINES (Horses)	Total examined	66
Biliary Fever	4	
Epizootic Lymphangitis	1	
Sarcoma	1	
Ulcerative Lymphangitis	21	
Ulcerative Lymphangitis (suspicious)	1	
Unsuitable for examination	1	
Negative	37	
EQUINES (Mules)	Total examined	16
Epizootic Lymphangitis	1	
Ulcerative Lymphangitis	9	
Negative	6	
OVINES	Total examined	116
Anthrax	1	
Bacillus necrosis	1	
Blue Tongue	2	
Cysticercus ovis	2	
Fluke (distoma)	3	
Heartwater	7	
Interlobular Cirrhosis	1	
Laikipia Lung Disease	1	
Pneumonia	3	
Unsuitable for diagnosis	2	
Negative	93	

PORCINES						Total examined	22
Anthrax						1	
Necrotic Tumour						1	
Unsuitable for examination						1	
Negative						19	
CAPRINES						Total examined	4
Anthrax						1	
Pleuro-pneumonia						1	
Negative						2	
CANINES						Total examined	39
Biliary Fever						3	
Sarcoma						1	
Rabies						1	
Tick Fever (<i>Pirop. canis</i>)						19	
Unsuitable for examination						2	
Negative						13	
FELINES						Total examined	2
Negative						2	
AVIANS (Fowls)						Total examined	107
Chicken Pox						3	
Egg Bound						2	
Fowl Typhoid (Kikuyu Fowl Disease)						52	
Peritonitis						6	
Roup						2	
Rupture of Egg Sack						4	
Ruptured Liver						1	
Salpingitis						1	
Unsuitable for examination						3	
Negative						33	
AVIANS (Turkeys)						Total examined	12
Aspergillosis						3	
Chicken Pox						2	
Fowl Typhoid (Kikuyu Fowl Disease)						4	
Ruptured Liver						1	
Negative						2	
AVIANS (Ducks)						Total examined	2
Negative						2	
VARIOUS.							
WILDEBEEST						Total examined	1
Rinderpest						1	
JACKALS						Total examined	2
Negative						2	
TICKS						Total examined	3
<i>Rhip. bursa</i>						}	1
<i>Rhip. pulchellus</i>							
<i>Rhip. appendiculatus</i>							
<i>Rhip. evertsi</i>						1	
<i>Hyalomma aegyptium</i>						1	
WORMS						Total examined	3
<i>Avitellina centripunctata</i>						}	1
<i>Bunostomum trigonocephalum</i>							
<i>Fasciola hepatica</i>						1	
<i>Hemonchus contortus</i>						}	1
<i>Trichuria ovis</i>							
PLANTS						Total examined	3
Poisonous						1	
Non-poisonous						2	

PREPARATION OF LABORATORY PRODUCTS FOR THE YEAR ENDING DECEMBER 31st, 1929.

PRODUCTS	Balance on hand 31-12-1928	Prepared by the Laboratory during the year	Returned to the Laboratory	Used in Laboratory	Issued during the year	Written off as too old for issue	Balance on hand 31-12-1929
Anthrax Vaccine 1st. ..	Nil	8,763	950	Nil	8,763	950	Nil doses
" " 2nd ..	"	8,863	950	"	8,863	950	" "
Blackquarter Vaccine Liquid ..	"	29,708	Nil	"	29,708	Nil	" "
Bluetongue Vaccine ..	14,318	4,650	"	121	9,549	"	9,298
Colon Bacillosis Vaccine ..	414	4,950	214	Nil	5,464	"	114
Contagious Abortion Vaccine ..	Nil	413	Nil	"	413	"	Nil
Chicken-pox Vaccine ..	"	1,804	"	"	1,804	"	"
Fowl Typhoid (Kikuyu Fowl Disease) Vaccine ..	"	13,445	"	"	13,445	"	"
Lakipia Lung Disease Vaccine ..	"	41,054	"	"	41,054	"	"
Pleuro-pneumonia Vaccine ..	"	53,464	"	"	53,464	"	"
Paratyphoid Serum ..	"	Nil	"	"	Nil	"	"
Paratyphoid Vaccine ..	"	1,601	"	"	1,601	"	"
Rinderpest Vaccine ..	"	15,921	"	"	15,921	"	"
Serum Anti-Rinderpest ..	73,185	513,555	26,595	800	594,010	5,975	12,550
Sheep-pox Vaccine..	Nil	19,295	Nil	Nil	19,295	Nil	Nil
Trypanblue—Bovine ..	188	619	"	34	733	"	"
" Canine ..	94	181	"	6	240	"	29
Ulcerative Lymphangitis ..	Nil	Nil	"	Nil	Nil	"	Nil courses
Wireworm Remedy Powder ..	109,200	887,100	"	"	806,300	"	190,000 doses

DETAILS OF ISSUES OF LABORATORY PRODUCTS, 1929.

PRODUCTS	Issued to Dept. Officers	Issued to Stock Owners	Other Countries	Total Issue for 1929
Anthrax Vaccine, 1st ..	4,142	4,621	Nil	<i>doses</i> 8,763
" " 2nd ..	4,142	4,721	"	8,863
Blackquarter Vaccine, Liquid	7,783	14,925	7,000	29,708
Bluetongue Vaccine ..	3,404	6,145	Nil	9,549
Colon Bacillosis Vaccine ..	841	4,623	"	5,464
Contagious Abortion Vaccine	20	393	"	413
Chicken-pox Vaccine.. ..	Nil	1,504	300	1,804
Kikuyu Fowl Disease Vaccine	1,465	11,370	610	13,445
Laikipia Lung Disease Vaccine	5,150	35,904	Nil	41,054
Pleuro-pneumonia Vaccine ..	30,370	23,094	"	53,464
Paratyphoid Serum	Nil	Nil	"	Nil
" Vaccine.. ..	"	1,601	"	1,601
Redwater and Anaplasmosis Vaccine	212	105	"	317
Rinderpest Vaccine	5,150	10,771	"	15,921
Serum Anti-Rinderpest ..	250,770	3,240	340,000	593,010
Sheep-pox Vaccine	Nil	18,295	1,000	19,295
Trypanblue—Bovine	741	32	Nil	773
" Canine	204	36	"	240
Ulcerative Lymphangitis ..	Nil	Nil	"	<i>courses</i> Nil
Wireworm Remedy Powder..	80,400	702,900	23,000	<i>doses</i> 806,300

RESEARCH.

RINDERPEST.

By J. Walker.

Research work carried out by the Chief Veterinary Research Officer prior to proceeding on vacation leave in May and since his return included the following, viz. :—

1. Potency tests of the serum of non-hyperimmunised cattle.
2. Potency tests of the serum of different bleedings after hyperimmunisation.
3. Prophylactic vaccination with *inactivated* Toluol treated spleen extract.
 - (a) Duration of immunity in cattle vaccinated prior to weaning.
 - (b) Duration of immunity in cattle vaccinated at various ages other than when unweaned.
 - (c) Conferring an active immunity with inactivated spleen pulp and fresh virulent blood in other than unweaned calves.
 - (d) Potency of peritoneal washings and blood respectively.
 - (e) Keeping properties of inactivated vaccine.

1. POTENCY TESTS OF THE SERUM OF NON-HYPERIMMUNISED GRADE CATTLE.

Tests were made of the serum of—

(a) A *recovered* virus maker, i.e., a beast which reacted to inoculation of virulent blood and was bled during the temperature reaction for virus for hyperimmunising serum makers, and had recovered.

(b) Two cattle which had been actively immunised by the serum simultaneous method, viz., 2 c.c. virulent citrated blood and simultaneously a dose of antiserum. (The serum of these two cattle was pooled.)

(c) A beast which had been vaccinated with inactivated spleen pulp.

Method of inoculation.—Three inoculations at intervals of seven days. The animal was bled for serum seven days after the last injection of vaccine. The vaccinated animal was tested on its immunity twenty-one days after the last injection of vaccine.

Result.—No reaction to Rinderpest. The animal being thus completely protected by the vaccine.

SUMMARY OF POTENCY TESTS FOR NON-HYPERIMMUNISED CATTLE.

1. Serum of recovered virus makers protected against death at the 10, 15, 20 and 30 c.c. index dose respectively, but not against a severe reaction at the 10 c.c. and 30 c.c. index dose. (4 in expt.)

2. Pooled serum of two cattle actively immunised by the simultaneous method protected against death at an index dose of 10, 15, 20 and 30 c.c. respectively, but not against a severe reaction at the 30 c.c. index dose.

3. Serum of a beast vaccinated with inactivated vaccine protected against a severe reaction at the 10, 15, 20 and 30 c.c. index dose respectively.

2. POTENCY TESTS OF THE SERUM OF DIFFERENT BLEEDINGS AFTER HYPERIMMUNISATION.

The method adopted by the writer for preparing anti-serum is as follows.

Grade cattle of from approximately three years old and upwards are actively immunised by the simultaneous method and a period of fourteen days allowed to elapse after the reaction has passed over; the immune animal is then hyper-immunised, i.e., virulent blood at the rate of 15 c.c. per kilo body weight is injected intramuscularly and several days later the animal is bled four litres once weekly for six weeks and the rhythm of hyperimmunisation and bleeding continued. The serum of different bleedings, i.e. 1, 2, 3, 4, 5 and 6 is mixed, the mixture constituting a brew. The number of serum makers in the serum making mob varies according to the output. For a monthly output of say 30,000 doses, approximately 150 are bled weekly.

SUMMARY OF POTENCY TESTS OF HYPERIMMUNISED CATTLE. (GRADES AND ONE NATIVE.)

1. Serum of the sixth bleeding after hyperimmunisation of bovine 9891 which had been used since July, 1927, for serum making, protected against death at an index dose of 10, 15, 20 and 30 c.c. respectively, but the reaction was severe at the 10 and 15 c.c. index dose and complicated with Red-water.

2. Serum of the first bleeding after hyperimmunisation of bovine 9891 which had been used since July, 1927 for serum making protected against death at index doses of 10, 15, 20 and 30 c.c. respectively, but the reaction was severe at the 10 and 15 c.c. index dose respectively and complicated at the 10 c.c. index dose with Redwater.

3. Serum of the sixth bleeding after hyperimmunisation of bovine 9909 which had been in use since October, 1928, for serum making protected against a severe reaction at the 10, 20 and 30 c.c. index dose respectively; the 15 c.c. index dose animal proved to be an immune beast.

4. Serum of the first bleeding after hyperimmunisation of bovine 9909 which had been in use since October, 1928, for serum making protected against a severe reaction at the 10, 15, 20 and 30 c.c. index dose respectively.

5. Serum of the sixth and first bleedings after hyperimmunisation of bovine 2794 which had been in use since January, 1929, for serum making protected against severe reaction at the 10, 15, 20 and 30 c.c. index dose respectively.

6. Serum of the sixth bleeding after hyperimmunisation of bovine 176 (native ox) which had been in use for serum making since January, 1926, did not protect against a severe reaction at the 10, 15 and 30 c.c. index dose respectively, or death at the 15 and 30 c.c. index dose respectively. (Serum maker 176 died prior to the date for the first bleeding after the next hyperimmunisation.)

GENERAL SUMMARY OF POTENCY TESTS OF NON-HYPERIMMUNISED AND HYPERIMMUNISED CATTLE.

1. Serum of a recovered virus maker and of actively immunised beasts (grades) was found to be less potent than the serum (first and sixth bleedings respectively) of hyperimmunised cattle (grades) which had been in use for serum making since October, 1928 and January, 1929 respectively.

(2) The serum of a grade beast which had been vaccinated with inactivated pulp protected against a severe reaction.

(3) The serum first and sixth bleedings respectively after hyperimmunisation of a grade beast which had been used for serum making purposes since July, 1927, corresponded in potency with that of the non-hyperimmunised virus maker and the actively immunised beast.

Serum sixth bleeding after hyperimmunisation of a *native* ox which had been used for serum making since 1926 was found less potent than any of the above.

Conclusions.

Owing to the small number of cattle in experiment and the variations which occur in the potency of the serum of individual cattle, it is unsafe to arrive at definite conclusions, but the indications are that (1) the serum of cattle which have been in use for some years as serum makers is less potent than that of recently introduced serum makers, and that the serum of a beast of average susceptibility (native) is less potent than that of cattle of high susceptibility (grades). The custom of adding fresh serum makers to the serum making mob, to replace cattle which have been in use for some time, and cattle which for various reasons, such as difficulty of bleeding and other causes are unsuitable, results in the production of an antiserum of *uniform potency*, the prescribed index dose is lower for cattle of average than for cattle of high susceptibility and does not block out a reaction to simultaneous inoculation of fresh virulent blood. An active immunity is conferred thus.

Potency tests carried out by the writer and recorded in the annual report of the Chief Veterinary Research Officer for the year 1925, which is embodied in the annual report of the Department of Agriculture, for the corresponding year, showed that a higher index dose of antiserum prepared in an adjoining territory than that prescribed for their cattle was required for Kenya cattle and from the recorded observations of comparative tests made in an adjoining territory it seems that the potency of serum prepared there from cattle of high susceptibility is higher than the Kabete serum and that a larger index dose of Kabete serum than that prescribed for Kenya cattle is required for some at least of their cattle. The variations in susceptibility of the cattle from which the serum is prepared in the adjoining territories appears to explain the differences in the potency of antiserum.

(2) The serum of a non-hyperimmunised recovered virus maker and of non-hyperimmunised actively immunised cattle, is less potent than that of hyperimmunised grade cattle, whilst that of a vaccinated beast possesses immunising properties.

(3) Serum of the sixth bleeding appears to be as potent as that of the first bleeding after hyperimmunisation.

3. PROPHYLACTIC VACCINATION WITH INACTIVATED TOLUOL TREATED SPLEEN PULP.

Immunity conferred in cattle treated with inactivated spleen pulp.

The literature is not definite on the period for which immunity is conferred by *inactivated* pulp. The writer recorded in the annual report of the Chief Veterinary Research Officer for 1927, which is embodied in the annual report of the Department of Agriculture for the corresponding year, page 121, that some of the cattle in which a complete resistance was conferred to a dose of virulent blood seven days after vaccination with inactivated spleen pulp, were not completely resistant on the ninety-seventh day after the date of the original immunity test.

Further investigations in connection with the immunity conferred by inactivated spleen pulp were carried out.

In May, 1929, a number of unweaned calves and cattle, other than unweaned, of varying ages were vaccinated with inactivated spleen pulp. All these animals were tested on their immunity a few days after the last dose of vaccine and were kept isolated from Rinderpest until the latter end of the year, when they were retested on their immunity against contact infection and/or inoculation of 2 c.c. of fresh virus.

The spleen pulp used for vaccination was prepared as follows, viz. :—

Spleens of reacting Rinderpest virus makers collected on the 1st March, 1929, minced through a Latapie mincer, the mince pooled and mixed with normal saline in the proportion of one of spleen pulp to four of saline and toluol added so as to make 1 per cent of the total bulk and then filtered through muslin and incubated for seventy-two hours at 38° C. and stored in the ice chest at from 5° C. to room temperature according to the availability of ice.

The experiments and results are detailed in Tables I and II, pp. 189-192.

TABLE I
(a) IMMUNITY IN CALVES VACCINATED PRIOR TO WEANING, WEANED 1-5-1929.

No. of unweaned calves	Age when vaccinated	Dates of vaccination	Method of inoculation	Immunity Test with tc.c. fresh virulent and dates	Result	Retested on Immunity Method and date	Result
X2873	<i>months</i> 9	5-3-29 12-3-29 19-3-29	Three inoculations each of 20 c. c. subcutaneous as seven days interval, each dose representing 4 granules of spleen pulp.	1-4-29 " " "	No reaction to Rinderpest ditto ditto ditto	30-11-29. Inoculated 2 c.c. fresh virulent blood. ditto Died 13-10-29. C.O.D. Anthrax.	Reacted to Rinderpest and recovered. Blood of 2873 transmitted Rinderpest. Reacted to Rinderpest, complicated with Redwater. Died 9-12-29.
X2933	7	5-3-29 12-3-29 19-3-29					
X2903	8	5-3-29 12-3-29 19-3-29					
X2907	8	5-3-29 12-3-29 19-3-29					
X2900	8	5-3-29 12-3-29 19-3-29					No reaction to Rinderpest. Seventh day temperature 106°, otherwise remained normal. No definite reaction to Rinderpest. No reaction to Rinderpest.
X3043	5½	5-3-29 12-3-29 19-3-29				2nd and 3rd January, 1930. Inoculated 5 c.c. fresh nasal virus each day. 10-12-29. Placed in contact with reacting Rinderpest Virus makers.	Marked reaction to Rinderpest from 3-1-30 to 12-1-30. Animal recovered.
X3099	5	5-3-29 12-3-29 19-3-29				30-11-29. Inoculated 2 c.c. fresh virulent blood.	Reaction to Rinderpest complicated with redwater. Died 10-12-29.

TABLE I—(Contd.).

(a) IMMUNITY IN CALVES VACCINATED PRIOR TO WEANING, WEANED 1-5-1929—(Contd.)

No. of unweaned calves	Age when vaccinated	Method of inoculation.	Dates of vaccination	Immunity test with 2 c.c. fresh virulent and dates	Result	Retested on Immunity Method and date	Result
X2912	<i>months</i> 7	Three inoculations each of 30 c. c. sub-cutaneous as seven days interval each	5-3-29 12-3-29 19-3-29	1-4-29	No reaction to Rinderpest	16-12-29. Placed in contact with reacting Rinderpest Virus makers.	Reaction to Rinderpest from 20-12-29 to 25-12-29. Recovered.
X2913	7	c. c. sub-cutaneous	5-3-29 12-3-29 19-3-29	"	ditto	16-12-29. Placed in contact with reacting Rinderpest Virus makers.	Reacted severely to Rinderpest from 30-12-29 to 8-1-30. Recovered
X2936	7	as seven days interval each	5-3-29 12-3-29 19-3-29	"	ditto	30-11-29. Inoculated 2 c.c. fresh virulent blood.	Marked reaction to Rinderpest complicated with redwater 5-12-29-11-12-29. Recovered.
X2930	7	dose re-presenting six grammes of	5-3-29 12-3-29 19-3-29	"	ditto	30-11-29. Inoculated 2 c.c. fresh virulent blood.	Reacted to Rinderpest. Recovered. (Blood of 2930 transmitted Rinderpest).
X3045	6	spicen pulp.	5-3-29 12-3-29 19-3-29	"	ditto	30-11-29. Inoculated 2 c.c. fresh virulent blood.	No definite reaction to Rinderpest.
X2935	7		5-3-29 19-3-29	"	ditto	10-12-29. Placed in contact with reacting Rinderpest Virus makers.	Reaction to Rinderpest from 31-12-29 to 3-1-29. Recovered.
X3050	5		5-3-29 12-3-29 19-3-29	"	ditto	10-12-29. Placed in contact with reacting Rinderpest Virus makers. Retested 21-1-30 with 10 c.c. fresh nasal virus.	No reaction to Rinderpest. Reaction to Rinderpest from 27-1-30-2-2-30. Recovered. Blood of 3050 transmitted Rinderpest.

TABLE II

(b) DURATION OF IMMUNITY IN CATTLE VACCINATED AT VARIOUS AGES, OTHER THAN WHEN WEANED.—*Contd.*

No. of animal and age	Method of Vaccination	Dates of Inoculation	Immunity Test and date	Result	Retested on Immunity Method and dates	Result
X3475 age 12 months	3 inoculations each of 20 c.c. at 7 days interval.	23-4-29 30-4-29 7-5-29	10-12-29. Placed in contact with reacting Rinderpest Virus makers.	ditto	21-1-30. Inoculated with fresh nasal virus.	Reacted to Rinderpest and recovered.
X5319 aged cow	3 inoculations each of 15 c.c. at 7 days interval.	22-4-29 29-4-29 6-5-29	13-1-30 inoculated fresh V.B.	2 c.c.	Reacted to Rinderpest and died. Max. morning temperature 103° on the 2nd and 4th days.	
X5320 aged cow	ditto	22-4-29 29-4-29 6-5-29	14-1-30 inoculated fresh V.B.	2 c.c.	Reacted to Rinderpest and recovered. Max. morning temperature 103.2° 8th day. 5320 was bled on the 22-1-30. Susceptible beast inoculated and produced reaction to Rinderpest.	
X5321 aged cow	ditto	22-4-29 29-4-29 6-5-29	ditto	ditto	Reacted to Rinderpest and died 14th day after inoculation. Maximum morning temperature 105° on the 6th and 7th days. 5321 was bled on the 22-1-30 and susceptible beast inoculated and produced a reaction to Rinderpest. Reaction to Rinderpest and died. Blood of 5323 transmitted Rinderpest.	
X5323 aged cow	ditto	22-4-29 29-4-29 6-5-29	4-2-30 inoculated V.B.	2 c.c. fresh		
X5325 aged cow	ditto	22-4-29 29-4-29 6-5-29	ditto	ditto	Reacted to Rinderpest and recovered. Blood of 5325 transmitted Rinderpest.	

TABLE II—(Contd.).

(b) DURATION OF IMMUNITY IN CATTLE VACCINATED AT VARIOUS AGES, OTHER THAN WHEN WEANED.

No. of animal and age	Method of Vaccination	Dates of Inoculation	Immunity Test and date	Result	Retested on Immunity Method and dates	Result
X3322 age 14 months	2 inoculations each of 80 c.c. at 7 days interval.	24-12-28 31-12-28	16-1-29. 2 c.c. fresh V.B.	No reaction to Rinderpest	2nd test 2-5-29. 2 c.c. fresh V.B. 3rd test 30-1-30. Inoculated 2 c.c. fresh V.B.	No reaction to Rinderpest. ditto.
X3326 age 14 months	2 inoculations each of 100 c.c. at 7 days interval.	24-12-28 31-12-28	10-1-29. 2 c.c. fresh V.B.	ditto	20-1-30. Placed in contact with reacting Rinderpest Virus makers. 31-1-30 Inoculated 2 c.c. fresh V.B.	Reacted to Rinderpest from the 6th day after inoculation of virulent blood and recovered.
X3470 age 14 months	3 inoculations each of 30 c.c. at 7 days interval.	12-3-29 19-3-29 26-3-29	10-4-29. Inoculated 20 c.c. fresh nasal virus collected from reacting Rinderpest Virus maker.	ditto	20-1-30. Placed in contact with reacting Rinderpest Virus makers. 31-1-30. Inoculated 2 c.c. fresh V.B.	Reacted to Rinderpest from the 5th day after inoculation of virulent blood and recovered.
X3723 age 18 months	3 inoculations each of 20 c.c. at 7 days interval.	8-4-29 15-4-29 22-4-29	30-4-29. Inoculated 2 c.c. fresh V.B.	ditto	30-11-29. Inoculated 2 c.c. fresh V.B.	Reaction to Rinderpest and recovered.
X3790 age 2 years	3 inoculations each of 20 c.c. at 7 days interval.	10-4-29 17-4-29 24-4-29	2-5-29. Inoculated 2 c.c. fresh V.B.	ditto	20-1-30. Placed in contact with reacting Rinderpest Virus makers.	Reacted to contact infection from the 16th day after contact and recovered.

SUMMARY OF IMMUNITY TESTS OF CALVES VACCINATED PRIOR TO WEANING.

Fourteen unweaned calves varying in age from five to nine months were vaccinated with inactivated spleen pulp in March, 1929. None reacted to Rinderpest from vaccination. Thirteen days later each got 2 c.c. fresh virulent citrated blood; none reacted to Rinderpest. During November and December, 1929, or January, 1930, thirteen were tested on their immunity; six being exposed to *contact infection* for varying periods; of the six, four=66 per cent approx., reacted to Rinderpest and recovered. Two=33 per cent approx. did not react. The latter two were retested on their immunity to inoculation of virus. One of these gave a definite reaction to Rinderpest.

The remaining seven, of the lot of thirteen, were retested on their immunity during November and December, 1929, *against inoculation of virus*; of these five=70 per cent reacted to Rinderpest. (Two=40 per cent of which died of Rinderpest complicated with Redwater.) Of the remaining two of the lot of seven, one did not react to Rinderpest; the remaining one gave an indefinite reaction.

SUMMARY OF IMMUNITY TESTS OF CATTLE VACCINATED OTHER THAN WHEN UNWEANED.

Eleven cattle varying in age from twelve months to ten years old were vaccinated with *inactivated* spleen pulp; two or three inoculations on varying dates between December, 1928, and May, 1929. None reacted to Rinderpest from vaccination. Five were tested on their immunity to inoculation of virus a few days subsequent to the completion of vaccination. *Result.* None reacted to Rinderpest. The eleven cattle were subsequently tested or retested on their immunity, either to *contact infection* or to *inoculation of virus*, with the following results.

Contact infection.—Four animals put in contact for periods varying from eleven to forty-two days.

Result.—One of the contact animals (No. 3790) reacted to Rinderpest from the sixteenth day; reaction mild and recovered. The remaining three did not react.

Infection by inoculation of virulent blood.—The three which did not react to contact infection were subsequently inoculated with virulent blood, the three, including 3475,

which had been in close contact for forty-two days and escaped infection, reacted to Rinderpest and recovered. Of the remaining seven cattle, six reacted to Rinderpest; of the six, three=50 per cent, died of Rinderpest.

Conclusions.

1. Three injections of inactivated toluol treated spleen extract followed thirteen days later with a dose of virulent blood does not protect (at least in the majority of cases) *unweaned calves* against contact infection or inoculation of virus after weaning. Possibly vaccination increases the natural resistance in unweaned calves born of immune mothers and in which case should be of assistance in overcoming the maintenance of infection which sometimes occurs in herds through unweaned calves, even when the latter have been serum simultaneously inoculated or treated with virulent blood. Some react severely to contact infection or inoculation of virus after weaning with some mortality. Some may escape contact infection (up to forty-two days) but are nevertheless non-resistant to inoculation of virus.

2. Cattle *other than unweaned* vaccinated with three injections at seven days' interval and which protects against a dose of virus some days later are not protected some months later against contact infection or inoculation of virus. Some may escape contact infection up to forty-two days, but are not protected against inoculation of virus.

A percentage react severely to virus with some mortality.

3. Inactivated vaccine does not confer an active immunity. The complete resistance conferred to inoculation of virus some days after completion of vaccination may have partially or completely disappeared after several months.

(C) CONFERRING AN ACTIVE IMMUNITY WITH INACTIVATED SPLEEN PULP AND FRESH VIRULENT BLOOD.

Experience both in the field and at the Laboratory has shown that to confer an active immunity in susceptible cattle, other than unweaned calves, by the serum simultaneous method, the use of fresh virulent blood is of fundamental importance and with a view of eliminating a factor which could be responsible for the non-setting up of Rinderpest and non-conferring of immunity *fresh* virulent blood was utilised

for the experimental inoculations carried out in 1927 and 1928 to determine whether an active immunity could be successfully conferred by inactivated spleen pulp and a simultaneous or subsequent dose of virulent blood. The results were recorded in the annual report of the Chief Veterinary Officer for the above-mentioned years and are briefly as follows, viz. :—

1. One injection of a dose of vaccine varying from 4 to 26 grammes of spleen pulp did not protect against a simultaneous inoculation of virulent blood; the reactions, even sometimes at the large doses, were usually severe and in some cases deaths occurred from Rinderpest.

2. One injection of large doses of vaccine, 12, 28 and 60 grammes of spleen pulp respectively, protected against a severe reaction to virulent blood inoculated six days later.

3. One inoculation of vaccine representing from 20 to 30 grammes of pulp did not protect against a marked reaction to virulent blood inoculated nineteen days later.

4. Two injections of vaccine, total dose representing from 6 grammes to 40 grammes of spleen pulp, at seven days' interval in 80 per cent of cases (ten in experiment) "blocked out" a reaction to virulent blood inoculated several days (seven to sixteen) after the last injection. Some of the non-reactors when retested on their resistance from three to twelve months later reacted.

5. Three injections of vaccine at seven days' interval "blocked out" a reaction to virulent blood inoculated a few days after the last dose of vaccine. It was subsequently determined that the resistance was not complete several months later.

Since a simultaneous inoculation of vaccine and virulent blood was found to be unsafe, and since Rinderpest was not set up by inoculation of fresh virulent blood several days subsequent to the last dose of three injections at seven days' interval of vaccine, the possibility of successfully conferring an *active* immunity by two injections of vaccine, and seven days later fresh virulent blood or one injection of vaccine and virulent blood at varying intervals after, was further investigated. In instances where cattle possibly susceptible to Red-water and Anaplasmosis were utilised in the experiments and

virulent blood free of these infections was not obtainable, fresh nasal virus was substituted, but in the few cases where no reaction occurred to inoculation of vaccine and a subsequent dose of fresh nasal virus, the immunity test was repeated with fresh virulent blood.

Three methods were employed for preparing the spleen pulp which for convenience are described as (a), (b) and (c) respectively.

Method (a).

The spleen of a reacting virus maker, No. 5131, was collected on the 13/1/30 during the height of the temperature reaction to Rinderpest and pulped in the Latapie pulper and to a portion of the pulp 0.4 c.c. of 9 per cent saline added for each gramme of pulp. The mixture was then shaken, kept at 5° C. for eighteen hours and 3.6 c.c. distilled water added for each gramme of the original material and commercial formalin added so as to make 1 in 800 of the total bulk. The treated pulp was then returned to the ice chest for seventy-two hours and stored at room temperature till used.

Method (b).

Another portion of the spleen of virus maker No. 5131 after being pulped was mixed with normal saline in the proportion of 1 gramme of pulp to 4 c.c. of saline, stored for eighteen hours at 5° C. and commercial formalin added so as to make 1 in 800 of the total bulk. The treated pulp was then returned to the ice chest at 50° C. for seventy-two hours and then stored at room temperature till used.

Method (c).

Another portion of the spleen of virus maker 5131 after pulping was mixed with normal saline at the rate of 1 of pulp to 4 of saline. Toluol was then added so as to make 1 per cent of the total bulk. The thus treated spleen was then incubated for ninety hours at 37° C. and stored at room temperature till used.

Method (a).—The experiments and results are detailed in Table III, p. 197.

TABLE III
RINDERPEST.
VACCINE PREPARED BY METHOD (a).

Bovine No.	Method of Inoculations	Date	Immunity Tests and Date	Result
X3840 age 8 months	One inoculation of 20 c.c.=4 grammes and tested on immunity after 7 days.	20-12-29	Inoculated 27-12-29 with 10 c.c. fresh nasal virus collected from reacting Rinderpest Virus makers. 16-1-30 2 c.c. fresh V.B.	Reaction to Rinderpest and recovered. Nil.
X3049 age 13 months	One inoculation of 20 c.c.=4 grammes and immunity test after 14 days.	20-12-29	Inoculated 3-1-30 with 5 c.c. fresh nasal virus collected from reacting Rinderpest Virus makers. 21-1-30 10 c.c. nasal virus collected from Rinderpest Virus makers.	No reaction to Rinderpest. No reaction to Rinderpest.
X3465 age 11 months	One inoculation of 20 c.c.=4 grammes and immunity test after 21 days.	20-12-29	Inoculated 10-1-30 with 5 c.c. fresh nasal virus collected from reacting Rinderpest Virus makers. 2 c.c. fresh V.B. 23-1-30.	No reaction to Rinderpest. Nil.
X3841 age 12 months	Two inoculations of 10 c.c. each. Total 4 grms. at 7 days interval and immunity test after 7 days following 2nd inoculation.	20-12-29 27-12-29	Inoculated 3-1-30 with 5 c.c. fresh nasal virus collected from reacting Rinderpest Virus makers. 16-1-30 2 c.c. fresh V.B.	No reaction to Rinderpest. Reaction to Rinderpest and recovered.
X2842 age 18 months	Three inoculations each of 7 c.c. total=4 grms. approx. at 7 days interval and immunity test after 7 days following 3rd inoculation.	20-12-29 27-12-29 3-1-30	Inoculated 10-1-30 with 5 c.c. fresh nasal virus collected from reacting Rinderpest Virus makers.	No reaction to Rinderpest.

Summary—Method (a).

A complete resistance to virus inoculated on the seventh day after injection of a single dose of vaccine, viz. 20 c.c. was not conferred.

A complete resistance to virus inoculated on the fourteenth day after injection of a single dose of vaccine, viz. 20 c.c. was conferred.

A complete resistance to virus inoculated on the twenty-first day after injection of a single dose of vaccine, viz. 20 c.c. was conferred.

A complete resistance to virus inoculated on the twentieth day after the last of two injections of vaccine was not conferred.

Note.—The animal was tested on its immunity on the seventh day after the last injection of vaccine to inoculation of nasal virus, but did not react.

A complete resistance to inoculation of virus seven days after the last of three injections of vaccine, each of 7 c.c. given at seven days' interval, the total dose for the three injections being approximately similar to that given for the single and the two inoculation methods respectively, was conferred.

Method (b).—The experiments and results are detailed in Table IV, p. 199.

TABLE IV
RINDERPEST.
VACCINE PREPARED BY METHOD (b).

Bovine No.	Method of Inoculations	Date	Immunity Tests and Date	Result
X3063 age 14 months	One inoculation of 20 c.c.=4 grammes and tested on immunity 7 days later.	20-12-29	Inoculated 27-12-29 with 5 c.c. fresh nasal virus collected from reacting Rinderpest Virus makers Inoculated 10-1-30 with 5 c.c. fresh nasal virus.	No reaction to Rinderpest. ditto.
X3106 age 13 months	One inoculation of 20 c.c.=4 grammes and tested on immunity 14 days later.	20-12-29	Inoculated 3-1-30 with 5 c.c. fresh nasal virus collected from reacting Rinderpest Virus makers 2 c.c. fresh V.B. on 16-1-30.	No reaction to Rinderpest. ditto.
X3328 age 12 months	One inoculation of 20 c.c.=4 grammes and tested on immunity 21 days later.	20-12-29	Inoculated 10-1-30 with 5 c.c. fresh nasal virus collected from reacting Rinderpest Virus makers. 2nd test 23-1-30 2 c.c. fresh virulent blood.	No reaction to Rinderpest. ditto.
X2931 age 16 months	Two inoculations of 10 c.c., total=4 grammes at 7 days interval and tested on immunity 7 days after 2nd inoculation.	20-12-29 27-12-29	Inoculated 3-1-30 with 5 c.c. fresh nasal virus collected from reacting Rinderpest Virus makers. 16-1-30 2 c.c. fresh V.B.	No reaction to Rinderpest. ditto.
X2934	Three inoculations of 7 c.c., total=4 grammes approx. at 7 days interval and tested on immunity 7 days after 3rd inoculation.	20-12-29 27-12-29 3-1-30	Inoculated 10-1-30 with 5 c.c. fresh nasal virus collected from reacting Rinderpest Virus makers.	No reaction to Rinderpest.

Summary—Method (b).

A complete resistance to virus inoculated on the seventh, fourteenth and twenty-first day respectively after injection of single doses of inactivated vaccine, viz. 20 c.c. was conferred.

A complete resistance to virus inoculated on the seventh day after the last of two inoculations each of 10 c.c. at seven days' interval, representing a total dose of 20 c.c., was conferred.

A complete resistance to inoculation of virus on the seventh day after the last of three injections of vaccine at seven days' interval, each injection consisting of 7 c.c., representing a total dose of 21 c.c. of vaccine, was conferred.

Method (c).—The experiments and results are detailed in Table V, p. 201.

TABLE V
RINDERPEST.
VACCINE PREPARED BY METHOD (c):

Bovine No.	Method of Inoculation	Date	Immunity Tests and Date	Result
X2843 age 20 months	One inoculation of 20 c.c.=4 grms. and tested on immunity 7 days later.	18-12-29	Inoculated 25-12-29 with 5 c.c. fresh nasal virus collected from reacting Rinderpest Virus makers 2nd test 10-1-30—(As 1st test). 3rd test 23-1-30 2 c.c. fresh V.B.	No reaction to Rinderpest to 1st or 2nd test. 3rd test no reaction to Rinderpest.
X2900	One inoculation of 20 c.c.=4 grms. and tested on immunity 14 days later.	18-12-29	Inoculated 2nd and 3rd January, 1930 with 5 c.c. fresh nasal virus collected from reacting Rinderpest Virus makers. 2nd test 16-1-30 2 c.c. fresh virulent blood.	No reaction to Rinderpest. Animal subsequently proved to be an animal previously in unweaned calves experiment.
X3507 age 10 months	One inoculation of 20 c.c.=4 grms. and tested on immunity 21 days later.	18-12-29	Inoculated 9-1-30 with 5 c.c. fresh nasal virus col- lected from reacting Rinderpest Virus makers.	Reaction to Rinderpest and died of Rinderpest 17-1-30. Redwater and anaplasmosis.
X3772 age 9 months	Two inoculations of 10 c.c., total=4 grammes at 7 days interval and tested on immunity 7 days after Se. and Inoculation.	18-12-29 25-12-29	Inoculated 2nd and 3rd January, 1930 with 5 c.c. of fresh nasal virus collected from reacting Rinderpest Virus makers.	Reaction to Rinderpest and recovered.
X5146	Three inoculations each of 7 c.c., total dosage=4 grammes approx. at 7 days interval and tested on immunity 7 days after last inocu- lation.	18-12-29 25-12-29 3-1-30	Inoculated 9-1-30 with 5 c.c. fresh nasal virus col- lected from reacting Rinderpest Virus makers. 2nd test 23-1-30 with 2 c.c. virulent blood.	No reaction to Rinderpest. ditto.

Summary.—Method (c).

The beast which was vaccinated with a single dose of 20 c.c. and tested on its resistance seven days' later to virus, did not react and was subsequently proved resistant to virulent blood.

The beast which was vaccinated with a single dose of 20 c.c. and tested on its immunity fourteen days later, was subsequently found to have been an immune beast prior to being put on experiment.

A resistance to inoculation of virus was not conferred on the twenty-first day after a single injection of 20 c.c. of vaccine. Animal died of Rinderpest complicated with a recurrence of Redwater and a reaction to Anaplasmosis.

A complete resistance to virus inoculated on the seventh day after the last of two injections of vaccine at seven days' interval, each of 10 c.c., representing a total dose of 20 c.c. was not conferred.

A complete resistance to inoculation of virus on the seventh day after the last injection of vaccine (three inoculations at seven days' interval) each of 7 c.c., representing a total dose of 21 c.c., was conferred.

The resistance conferred by a single injection of vaccine, even by a large dose, to virulent blood some days later was found in some cases insufficient to protect against severe reaction and death and the following was investigated, viz. :—
(1) Whether three injections of vaccine at seven days' interval "blocks out" a reaction to virus inoculated simultaneously with the last injection; (2) Whether two injections of vaccine at seven days' interval "blocks out" a reaction to virus inoculated simultaneously with the second injection.

See Tables VIII, p. 209. (Keeping properties of inactivated toluol treated spleen.)

Summary.

Three, and in some cases two, injections of inactivated toluol treated spleen extract at seven days' interval "blocks out" a reaction to virus simultaneously inoculated with the last dose.

The possibility of successfully conferring an active immunity with two smaller doses of inactivated spleen extract at seven or at ten days' interval and simultaneously with the last dose *fresh* virulent blood was next investigated.

The extract utilised was prepared as follows : The spleens of four virus makers were collected during the latter stages of the temperature reaction, minced in a Latapie and mixed with normal saline in the proportion of 1 of mince to 4 of saline, commercial formalin (38.1 per cent Formaldehyde) added so as to make 1 in 800 of the bulk. The thus treated pulp was stored overnight at 1° C., filtered through muslin, incubated for forty-eight hours prior to use to ensure *inactivity* of the virus.

The details of the experimental inoculations and results are given in Table VI, p. 204.

TABLE VI

RINDERPEST.

TWO INOCULATIONS OF VACCINE AT 7 AND 10 DAYS INTERVAL AND SIMULTANEOUS AT TIME OF LAST INOCULATION OF VACCINE
DOSE OF *Fresh* VIRULENT BLOOD.

No. of Animal	Age	Weight	Doses of Vaccine and Dates	Résult
X5412	18 months	113 kilos	5 c.c.=2 grms. spleen 5 c.c. and 2 c.c. V.B.	Reaction to Rinderpest from the 4th day. Temperature remained elevated until the 7th day reaching a maximum of 105.6° on the 5th day. No mouth lesions or diarrhoea. Animal recovered.
X5416	18 months	120 kilos	10 c.c.=4 grms. spleen 10 c.c. and 2 c.c. V.B.	Reaction to Rinderpest from the 4th day. Temperature remained elevated until the 8th day reaching a maximum of 104.2° on the 7th day. No mouth lesions or diarrhoea. Animal recovered.
X5421	18 months	116 kilos	20 c.c.=8 grms. spleen 20 c.c. and 2 c.c. V.B.	Reaction to Rinderpest from the 4th day. Temperature remained elevated until the 6th day reaching a maximum of 105.6° on the 5th day. No mouth lesions or diarrhoea. Animal recovered.
X5413	18 months	170 kilos	5 c.c.=2 grms. spleen 5 c.c. and 2 c.c. V.B.	Reaction to Rinderpest from the 2nd day. Temperature remained elevated from the 2nd to 9th day reaching a maximum of 106.4° on the 4th day. Mouth lesions. Diarrhoea. Animal recovered.
X5420	18 months	130 kilos	10 c.c.=4 grms. spleen 10 c.c. and 2 c.c. V.B.	Reaction to Rinderpest from the 3rd day and temperature elevated from the 3rd to 9th day reaching a maximum of 106.4° on the 4th and 5th days. Mouth lesions. Animal recovered.
X5414	18 months	120 kilos	20 c.c.=8 grms. spleen 20 c.c. and 2 c.c. V.B.	Reaction to Rinderpest from the 3rd day. Temperature remained elevated from the 3rd to 10th day reaching a maximum of 105.4° on the 4th day. Mouth lesions and diarrhoea. Animal recovered.

Summary.

(1) Two injections at seven days' interval of inactivated formalised spleen extract representing a total dose of 2, 4 and 8 grammes respectively of spleen pulp, protected grade cattle against a severe reaction to virus inoculated simultaneously with the second dose. The three cattle in experiment recovered.

(2) Two injections at ten days' interval of inactivated formalised spleen extract representing a total dose of 2, 4 and 8 grammes respectively of spleen pulp did not protect against a marked reaction to virus inoculated simultaneously with the second dose. The three cattle in experiment recovered.

(3) The reaction to the virus was of shorter duration in the cattle which received two injections at seven days' interval in comparison with that which usually occurs in cattle serum simultaneously inoculated with the average prescribed dose for cattle of a similar type, whilst the reaction to the virus in the cattle injected at ten days' interval was marked in two, 5420 and 5414, and particularly severe in 5413.

Conclusions.

(1) A single dose of formalised inactivated spleen extract sometimes "blocks out" a reaction to *fresh* virus inoculated seven, fourteen or twenty-one days later.

(2) Two injections of formalised inactivated spleen extract at seven days' interval sometimes "blocks out" a reaction to *fresh* virus inoculated seven days after the second injection.

(3) Three injections at seven days intervals "blocks out" a reaction to fresh virus inoculated seven days after the third injection.

(4) The same quantity of vaccine which "blocks out" a reaction when given as three injections at seven days' interval, does not necessarily "block out" a reaction when given as a single dose, or as two doses at seven days' interval.

(5) A greater resistance to be conferred by two injections of inactivated vaccine at seven days' interval than by two injections at ten days' interval; in each case to simultaneous

inoculation of virus with the last injection, but in view of the individual variations in susceptibility which occur in cattle, further experimental inoculations of a number of cattle of average and high susceptibility should be carried out with a "brew" of vaccine, the index dose of which should have previously been ascertained for cattle of average and high susceptibility, to determine whether two injections of vaccine at seven days' interval and simultaneously a dose of fresh virulent blood at time of last injection can be *safely* employed in the practice for conferring an active immunity in 100 per cent of susceptible cattle.

(D) POTENCY OF PERITONEAL WASHINGS AND BLOOD
RESPECTIVELY.

(a) *Peritoneal Washings.*

Method of preparation.—A reacting virus maker was injected intraperitoneally with three litres of an 0.6 per cent potassium nitrate solution in distilled water several hours prior to being bled to death for virus, commercial formalin added to make a dilution of one of formalin to 800 of washings, and the washings kept at 1° C. for ninety hours and then at room temperature till used.

(b) *Blood.*

The blood was treated by two methods, viz. (a) and (b).

Method (a).—A reacting virus maker was bled 2,000 c.c., the coagulated blood stored at 5° C. for seventy-two hours and the serum decanted. Sixteen hours later the coagulum was minced in a Latapie and for every gramme of mince 0.4 c.c. of a 9 per cent solution of normal saline added; the mixture then stored at 5° C. for eighteen hours and 3.6 c.c. of distilled water added to each gramme of the original mixture, and commercial formalin so as to make a dilution of one of formalin to 800 of the bulk. The thus treated blood was then kept at room temperature till used.

Method (b).—A portion of the coagulum was mixed after mincing with normal saline in the proportion of 1 gramme of mince to 4 c.c. of saline, commercial formalin then added to make a dilution of one of formalin to 800 of the mixture, and stored at room temperature till used.

The experiments and results are detailed in Table VII., p. 207.

TABLE VII
RINDERPEST.
POTENCY TESTS OF PERITONEAL WASHINGS.

No. of Bovine	Dosage	Dates	IMMUNITY TEST		
			Inoculated	Date	Result
X5083	3 injections each of 50 c.c. at 7 days interval (subcutaneously).	20-12-29 27-12-29 3-1-30	5 c.c. of fresh nasal virus subcutaneously.	10-1-30	Reacted and died of Rinderpest.
POTENCY TESTS OF BLOOD TREATED BY METHOD (a).					
No. of Bovine	Dosage	Dates	IMMUNITY TEST		
			Inoculated	Date	Result
X4625	3 injections each of 50 c.c. at 7 days interval (subcutaneously)	20-12-29 27-12-29 3-1-30	5 c.c. fresh nasal virus subcutaneously.	10-1-30	Reacted and died of Rinderpest.
POTENCY TESTS OF BLOOD TREATED BY METHOD (b).					
No. of Bovine	Dosage	Dates	IMMUNITY TEST		
			Inoculated	Date	Result
X2905	3 injections each of 50 c.c. at 7 days interval (subcutaneously).	20-12-29 27-12-29 3-1-30	5 c.c. fresh nasal virus subcutaneously.	10-1-30	Reacted and died of Rinderpest.

Summary.

Peritoneal washings or blood of a reacting virus maker did not protect against a dose of virulent blood inoculated seven days after the last injection.

Conclusions.

Inactivated peritoneal washings or blood treated as described above possess no immunising properties.

(E) KEEPING PROPERTIES OF INACTIVATED TOLUOL TREATED SPLEEN EXTRACT.

In 1929 the writer recorded in the paper "Rinderpest Research in Kenya" contributed to the Pan-African Veterinary Conference, August, 1929, that the inactivated pulp was still potent after three months storage at approximately 5° C.

The keeping properties were further investigated; a batch of toluol treated spleen extract was prepared on the 24/5/29 and stored at 5° C. in a rubber stoppered flask until the 19/1/30, when it was tested on its keeping properties as shown in Table VIII, p. 209.

TABLE VIII
RINDERPEST.
 KEEPING PROPERTIES OF INACTIVATED TOLUOL TREATED SPLEEN EXTRACT.

No. of animal	Method of Inoculation	Dates of Inoculation	Result
3048—age 12 months	2 inoculations each of 40 c.c. at 7 days interval plus 2 c.c. V.B. simultaneously with 2nd inoculation of vaccine.	9-1-30 16-1-30	Reaction to Rinderpest from 5th and 7th day. Max. temperature 106° on 5th day. Animal recovered.
2418—age 18 months	2 inoculations each of 60 c.c. at 7 days interval plus 2 c.c. V.B. simultaneously with 2nd inoculation of vaccine.	9-1-30 16-1-30	No reaction to Rinderpest.
3180—age 12 months	3 inoculations each of 40 c.c. at 7 days interval plus 2 c.c. V.B. simultaneously with 3rd inoculation of vaccine.	9-1-30 16-1-30 23-1-30	No reaction to Rinderpest.
3331—age 12 months	3 inoculations each of 60 c.c. at 7 days interval plus 2 c.c. V.B. simultaneously with 3rd inoculation of vaccine.	9-1-30 16-1-30 23-1-30	No reaction to Rinderpest.
5296—age 18 months	1 inoculation of 40 c.c. and tested with 2 c.c. V.B. 7 days later.	17-1-30	Marked reaction to Rinderpest from 3rd to 8th day reaching max. temperature of 107° 3rd day. Animal recovered.
5298—age 18 months	1 inoculation of 40 c.c. and tested with 2 c.c. V.B. 14 days later.	17-1-30	6th day temperature 104°. 7th day temperature normal.

Summary.

Three injections still produced a "block out" reaction to virus. Two injections sometimes conferred a complete resistance to virus inoculated simultaneously with the last dose. One inoculation did not protect against a severe reaction to virus inoculated seven days later, but protected almost completely at the same dose against virus inoculated fourteen days later.

Conclusions.

Inactivated toluol treated spleen extract.—The immunising body is still present in inactivated toluol treated spleen extract seven-and-a-half months after preparation and storage at 5° C.

RINDERPEST.

By R. Daubney.

The following is a copy of the report submitted by the Assistant Chief Veterinary Research Officer (Mr. R. Daubney) of the work carried out by him in connection with Rinderpest, viz. :—

- (1) Rinderpest prophylactic vaccination.
- (2) Transmission of Protozoan diseases through Rinderpest double inoculation.

(1) RINDERPEST PROPHYLACTIC VACCINATION.

Experiments on prophylactic vaccination against Rinderpest have been continued as far as conditions during the year have allowed. From May, 1929, to the end of the year, it was not possible to plan any extensive animal experiments at the Laboratory, owing to the demand made upon the resources of the institute by the production of large quantities of Anti-Rinderpest Serum for the Uganda Government. As a result of early observations, the tissues normally used in the preparation of vaccine were employed in the process of hyper-immunization of serum makers, thus creating a shortage of experimental material for the investigation of problems connected with vaccination.

Certain field work has, however, been carried out, and attention to the details of preparation has resulted in the introduction of certain improvements in the technique of preparation.

Field Work.—To refer first to the field work, this has consisted of a number of immunity tests of animals vaccinated in December, 1927, and January, 1928; and a number of fresh experimental treatments in the field with two doses of completely inactivated vaccine.

The results of test inoculations of animals vaccinated at the end of 1927 have been reported in a communication to the Pan-African Veterinary Conference, Pretoria, Bulletin 8b of 1929, and call only for brief comment here. It will be recalled that animals were inoculated on two farms termed respectively A and B. On farm A two types of vaccine were used and a single dose of each was given. Type (1) was a partially attenuated vaccine which had produced a small percentage of temperature reactions in experimental animals inoculated at the Laboratory. On farm A this vaccine gave rise to Rinderpest, which resulted in a mortality of 16.5 per cent of the inoculated animals. The second type of vaccine used was a completely inactivated preparation, and it was employed for the immunization of pregnant animals. Twenty-three pregnant cattle were inoculated with the Type (2) vaccine on this farm, and none of them showed any reaction to the inoculation. These animals were in contact with the remainder of the herd through the reaction engendered by the partially attenuated vaccine, but in no case was Rinderpest contracted, nor did any temperature reaction result from this contact exposure.

It was intended to test vaccinated animals on this farm during the present year and a double inoculation was, in fact, carried out, but owing to failure to make these animals distinctively, it was not possible to recognise individuals and the results are of no value as an experimental record.

On farm B four types of treatment were undertaken. Type (1) consisted of a single dose of partially attenuated vaccine similar to that used on farm A. This vaccine provoked temperature reactions in 108 weaner animals out of a

total of 127 inoculated. There were no deaths and some six animals only showed symptoms of clinical Rinderpest. The effect of this inoculation was not dissimilar from that of the average serum simultaneous inoculation, though possibly a little less severe.

Type (2).—Sixty-two weaners and seventeen pregnant cows were vaccinated with a completely inactivated vaccine of the type used on farm A. No reactions were experienced in these animals, nor in the 169 animals inoculated with this preparation as a first vaccine, and included in type (3).

Type (3).—169 animals were inoculated with vaccine type (2), of the same batch and on the same day as the seventy-nine animals mentioned above; there were no reactions. Seven days later these animals were reinoculated with a partially attenuated vaccine similar to that described as Type (1) which had produced 108 reactions out of 127 animals inoculated without any previous preparation. Of 169 animals receiving this vaccine as a second inoculation, four only showed transient temperature reactions on or about the sixth day. There were no symptoms of Rinderpest. The remaining 165 animals were evidently in a refractory state as a result of the first inoculation of completely inactivated vaccine seven days previously.

Type (4) consisted of a lot of forty animals inoculated with a vaccine that had never produced reaction in experimental animals, but which was intermediate in virulence between Type (1) and Type (2). This lot of animals was not suitable for testing, since it was in contact with 127 animals of Type (1) throughout the reaction and was only vaccinated subsequently to eliminate any possibility of persistence of infection.

In the early part of 1929 a sample was drawn from each of the lots 1, 2 and 3, and through the kindness of the owner, Sir John Ramsden, it was possible to remove these animals to the Laboratory for the purpose of testing with virulent blood. The results of these tests, which took place from twelve-and-a-half to fifteen months after vaccination, are shown in Table 3, reproduced from Bulletin 8b.

TABLE III.

VACCINE TYPE (1)	VACCINE TYPE (2)	VACCINE TYPE (3)
Total 29	Total 24	Total 37
3335	3340	3337
3336	41 Temperature	38
43	reaction	39
45	42 ditto	47
48	44 ditto	49
	46	
3598		3600
99	3609	01
3602	14	03
04	21 Rinderpest	05
08	23	06 Temperature
10 Temperature	25	reaction
reaction	29 Temperature	07
11	reaction	12
13	35	22
15	36	26
16	37	28
17	41	30
18	43 Rinderpest	34
19	45	38
20 Temperature	46 Temperature	39
reaction	reaction	40
24	48	42
27	53 Temperature	44
31	reaction	47
32	64	49
33	65 Temperature	50
51	reaction	55
52	66 Rinderpest	56
54	68 Temperature	3657
59	reaction	58
63		60
		61
		62
		67
		69
		70
		71
		72

It will be observed that the first five animals in each batch are separated from the remainder by a line. These fifteen animals were submitted to contact exposure to Rinderpest lasting three weeks before being tested by inoculation of virulent blood. The contact exposure was the heaviest that it was possible to arrange in the infected stables at the Laboratory, but in spite of this, no reactions of any kind were observed throughout the period. When, at the termination of this period of contact exposure, these animals were given a test inoculation of roughly some 7,000 minimal infective

doses of virulent blood three animals out of five exposed in Group (2) showed temperature reactions as a result of the test inoculation. These results are striking, but not altogether unexpected, since it is only reasonable to suppose that the dose-rate in ordinary contact infection will be much below that represented by the massive inoculation of some 7,000 minimal infective doses of virus.

Taken as a whole results of the test by virulent blood inoculation are extremely interesting. In the case of Type (2) vaccine which was expected to provoke the weakest immunity, eleven animals out of twenty-four reacted to the test inoculation. Eight of these animals showed temperature reactions only, and three mild clinical symptoms of Rinderpest. There were no fatalities. The previous experience with contact infection suggests that had these twenty-four animals been exposed to contact infection only, it is probable that none of the eight animals that showed temperature reactions alone, would have reacted at all to natural infection, leaving a contact attack rate in this group of 3, i.e. those animals that showed clinical Rinderpest after test inoculation.

In group (1) two animals showed mild temperature reactions only. In the one case, 3610, only one morning temperature over 103 was registered; this was 103.6 on the sixth day. In the other case, 3620, the temperature on the seventh day rose to 105.4 in the morning, fell on the eighth day to 105, fell to 104.2 on the ninth day, to 102 on the tenth day, and was normal from then on. In view of the high infection rate as indicated by temperature reactions at the time of inoculation of these animals with Type (1) vaccine, namely 108 out of 127, it was to be expected that these animals would show a degree of immunity comparable to that resulting from a natural outbreak of the disease, or from a successful simultaneous inoculation.

Type (3).—The sample of animals tested included thirty-seven animals from group (3), and of these one only, 3606, reacted to the test inoculation. This animal's temperature rose on the evening of the ninth day after inoculation, and was 104 on the morning of the tenth day; from then on it was normal. Sub-inoculation of the blood was not carried out, so that it is not possible to state with certainty that the reaction was due to Rinderpest. At all events, one may fairly state that vaccine Type (3) gave as good results on test as vaccine Type (1). The interesting feature of this result lies in the reactions that were observed as a result of the actual vaccinations in these two groups. In group (1) 108 reactions occurred out of 127. In group (3) a vaccine

similar to that employed as Type (1), but given as a second inoculation after a preliminary dose of vaccine Type (2), produced only four transient temperature reactions out of 169 animals inoculated; and in spite of this, succeeded in provoking an immunity comparable to that resulting from the use of Type (1) alone, and vastly greater than that produced by a single dose of the completely inactivated vaccine Type (2) which had been used as a first vaccine.

The experimental data are considered in detail in the Bulletin No. 8b of 1929 and it will be sufficient here to refer briefly to certain factors that must be taken into consideration in any evaluation of these results.

The statistical soundness of the experiment.—The samples from each batch were selected at random and an effort was made to obtain thirty of each type. Unfortunately, similarity of the brands of Types (2) and (3) resulted in errors during selection and when careful examination of brands was undertaken at the Laboratory, it was found that rather more animals of Type (3) has been selected. That this fact, however, in no way invalidated the results is proved by statistical examination. Details are given elsewhere, but it may be stated that if the samples from all three groups are considered as a whole, the odds against such a distribution of immunity occurring fortuitously are 50,000 to 1. This disposes also of a second possibility, namely, that the immunization might be the result of natural incidence of Rinderpest in the interim between vaccination and testing. A third question to be considered is the degree of susceptibility of the animals before vaccination. The animals were an even lot, all of about the *same age*, and the proportion of reactions observed in the 127 animals inoculated with vaccine Type (1) may be taken as a fair index of the susceptibility. Of these animals 108 reacted out of 127 inoculated, i.e. roughly 85 per cent., although the vaccine used was partially attenuated and by no means represented virus in its most virulent form.

It might be pointed out that these animals were weaners, and that a number of them had been weaned specially only a few days before vaccination. Other workers have tested animals that have been weaned for periods in excess of one month before inoculation, and in a series of observations by Rabagliati, ninety-eight of such weaned calves were inoculated by the simultaneous method. When tested on their immunity from three to seven months after inoculation, four of the ninety-eight animals developed Rinderpest and one died as a result of the test inoculation of virulent blood. There is no record of the occurrence of temperature reactions unassociated

with symptoms of Rinderpest in any of the calves, but in the light of the writer's experience, a number of such reactions must have occurred. In the tests of vaccinated animals recorded here, three animals only out of ninety developed Rinderpest and in each case the attack was so mild that there was never any question of mortality. Moreover all three cases of Rinderpest occurred in the one class, Type (2), which had been inoculated with a single dose of the weakest type of antigen, and the period elapsing between vaccination and testing varied from twelve to more than sixteen months. It will be evident then that an immunity can be conferred by vaccination, which on the basis of comparison with that provoked by a serum simultaneous inoculation merits the most careful consideration.

One other point must be mentioned in connection with these experiments. Numerous workers in other countries have objected to the use of serum simultaneous inoculation as a routine method of Rinderpest control on the ground that the disease is spread during the course of inoculations, and that it is not possible to eradicate Rinderpest from a country where widespread use is made of this method of immunization. In fact it is quite probable that the long duration of the immunity conferred by the serum simultaneous method, in countries where this method is widely practised, is largely dependent upon the frequent recurrence of symptomless infections derived from centres of disease set up during double inoculations; since there now can be little doubt that in animals completely guarded from all risk of reinfection immunity begins to decline at between two and three years after serum simultaneous inoculation. The type of inoculation represented by group (3) appears to be almost entirely free from this objection. A very high grade immunity is conferred and the reactions amount to something over 2 per cent, and those of an extremely mild character. It would appear that the risk of spreading infection from such reacting animals is negligible. Animals on certain farms have now been vaccinated for periods in excess of two years, and in some cases the environment of these animals has so altered, as a result of the adoption of vaccinations on surrounding farms, that any chance of their immunity being renewed by symptomless reinfection is practically excluded. This is a factor that must be given due consideration in any attempt to assess the probable value of vaccination by the application of long term immunity tests to the protected animals.

Further Field Inoculations.

It was decided at the beginning of the year that it was not the policy of the Department to make use of any type of vaccine that might provoke any reaction to Rinderpest whatever, and in those inoculations that have been carried out during the present year, completely inactivated vaccine only has been used. A large number of animals has been inoculated with two doses of completely inactivated vaccine, roughly of the type referred to in previous experiments as Type (2), and sufficient of these animals will later be available for testing. Results of experiments carried out in the Laboratory lead one to expect that such a method of vaccination will confer an immunity, which, while greater than that provoked by a single injection of completely inactivated vaccine, Type (2), will not be so high as that provoked by the two-dose method already employed, and previously referred to as Type (3).

The Value of Combination of a Killed and an Attenuated Vaccine.

It has been suggested in a recent publication by Jacotot from French Indo-China, that the immunity conferred by vaccination with completely inactivated products differs from that provoked by an actual infection. According to Jacotot, the immunity provoked by vaccination with inactive products does not protect an animal against subsequent invasion by the virus, but allows an infection to be established, and then exercises sufficient control over the already established infection to prevent the development of a serious reaction. A similar idea lies, no doubt, behind the recommendation of Laidlaw and Duncan in distemper vaccination that inactivated distemper vaccine should be followed by a dose of active virus in order to establish a permanent immunity. That the matter is not so simple as Jacotot contends is well established by experiments carried out in this Laboratory. Animals have been temporarily immunised by one or more doses of completely inactivated vaccine, and have resisted a subsequent inoculation of virulent blood shortly after vaccination. Some months later a second inoculation of virulent blood has provoked a temperature reaction or actual Rinderpest, indicating that at the time of the first test inoculation the virus failed to establish itself in the vaccinated animal. In the light of the experiments already recorded here, and of those now in progress, it does seem probable that inoculation with some form of virus not completely inactivated is necessary if

the immunity provoked is to last for any very considerable period. The use of partially attenuated virus as a second vaccine following a completely inactivated first vaccine, as in the Type (3) inoculations of 1927, appears to be the ideal method of provoking a persistent immunity, providing that certain factors can be adequately controlled. By this method one can reinforce and render more permanent the less durable immunity already provoked by injection of a completely inactivated vaccine, without any necessity for the production of marked reactions. Reference to the results of such an inoculation, Type (3), will substantiate this statement.

The position with regard to the use of a fully-active virus in the form of virulent blood is quite different. It has been shown already, by experiments at this Laboratory, that injection of small or moderate doses of fully virulent blood into animals that are partially or temporarily immune as a result of previous treatment with completely inactivated vaccine, reinforces this partial immunity only when infection is established, and that in many cases such an inoculation of virulent blood is entirely without effect upon the immune state of the animal. Why this should be so is difficult to explain at the present time. It is possible that the reinforcing effect exerted by an attenuated virus in the form of spleen tissue vaccine is merely a result of the greatly increased dose of virus given. The amount of spleen used in the preparation of 20 c.c. spleen vaccine contains, if the vaccine is to be a good one, something like 40,000 minimal infective doses of virus, corresponding roughly to some 40 c.c. of whole virulent blood, or about sixteen times the usual test dose. Some evidence in support of this view may be derived from the study of certain experiments made at Kabete. It has been observed repeatedly that the inoculation of immune animals with small doses of virulent blood (*circa* 2500 minimal infective doses) not only fails to render permanent a temporary immunity in certain vaccinated animals, but fails equally to stimulate the production of anti-bodies in animals already possessing a complete immunity of old standing. If, however, one increases the dose of virulent blood to that generally employed in hyperimmunisation, that is, roughly, to some three litres or about 3,000,000 minimal infective doses, these completely immune animals will respond by the production of a large amount of anti-body, which is readily demonstrable through its protective action upon susceptible animals, *vide infra*. Further observations are required, however, before any definite conclusions can be drawn on this matter.

Two factors in connection with the preparation of an attenuated vaccine which require careful control are :—

(a) The preservation of a relatively fixed degree of virulence in the attenuated virus, and

(b) Control of bacterial infection in the final product.

It should be possible by a series of careful observations to set a definite limit upon the period for which a partially attenuated vaccine may be stored without any appreciable deterioration in its antigenic power. The second factor, that of control of accidental bacterial infection, depends merely upon the elaboration of successful manufacturing technique. Certain unfortunate experiences with a vaccine to which an insufficient quantity of formalin had been added, have informed us of the types of organisms likely to give trouble in this connection, with the result that tests for the safety of vaccines in this respect have been devised both by cultural methods and by inoculation of small animals such as mice and guinea pigs.

As a result of the experiences of almost three years, it appears highly probable that the method of vaccination first with completely inactive vaccine and then with an attenuated vaccine, is likely to prove the most useful in this country.

Technique of Vaccine Production.

Certain observations have been made upon the vaccine prepared according to the method of Kelser, with a view to the comparison of Kelser's vaccine with a formalised vaccine as prepared in this Laboratory.

In the first place it is notable that Kelser considers liver a suitable tissue from which to prepare vaccine, although Boynton states that liver is not a suitable antigen. The Japanese workers and the present writer both concluded that liver was of no value in the preparation of a vaccine, but in view of Kelser's report, further tests were carried out. It was found that a liver vaccine prepared according to Kelser's method produced no immunity to Rinderpest, even when given in enormous doses. A similar result was experienced with a liver vaccine prepared according to the method in general use at this Laboratory. When spleen vaccine prepared by Kelser's method was compared with a formalised spleen vaccine of Tye (2), prepared from portions of the same spleen, the results were distinctly in favour of the formalised vaccine.

Some difficulty was experienced as a result of variation in the strength of formaldehyde in ordinary commercial formalin. The alteration in strength was in each case on the side of diminution, and undoubtedly resulted from polymerization. Titration of formaldehyde by the official method and adjustment to compensate for the loss at once restored the action of the product to normal.

An alteration in the technique of vaccine production has resulted in an improvement in the distribution of antigenic material as between the solid and fluid constituents of the vaccine, and an improvement in the condition of the final product. The new method, which is based upon the suggestion made by Murray to Hindle, who was preparing a similar vaccine for yellow fever, consists in the explosion of tissue cells under the osmotic pressure of a concentrated salt solution. It will be recalled that in previous papers the writer has pointed out that Rinderpest virus is firmly bound to the white cells, and that it is impossible by grinding or applying the ordinary methods of desorption, to liberate the virus from the cells in any considerable amount. In Murray's method a small quantity of concentrated (9 per cent) salt solution is first added to the pulped tissues, and later the salt concentration is brought back to physiological strength by the addition of nine times the quantity of distilled water. The osmotic pressure exerted by the salt in the tissues liberates the virus by exploding the cells and detaching the cytoplasm from the nuclei. An additional effect of this method, which is of considerable value in the preparation of Rinderpest vaccine, is that the pulp of the gland is completely stripped from the fragments of the fibrous trabeculae, which may then be removed by some appropriate method of screening.

When spleen extracts are prepared by trituration of the tissues with sand and normal saline, tests by the method of dilution indicate that the infectivity of the extract is extremely low. When minced spleen is treated by the osmotic explosion method the minimal infective dose of extract of a good spleen is less than 1/10,000 part of a gramme. The even distribution of virus in the final product, and the finely divided state of the tissue remaining after the fibrous trabeculae have been removed by screening, renders it possible to test with extreme accuracy, down to minute dilutions, the virus content of the tissues used for vaccine production.

Tests carried out at the Laboratory indicate that the potency of a vaccine is in direct proportion to the amount of virus contained in the vaccine producing material. It is possible in this way to compare not only the tissues of different animals, but to calculate also the comparative efficacy of different tissues from the same animal. By the application of this method we have reached the stage at which a standard minimal virus content per unit of vaccine can be laid down, and tissues not reaching this standard virus content can be discarded or can be used in proportionately higher doses to compensate for their decreased antigenic content. It is considered that tissues, in order to produce a vaccine of the highest grade, should contain something in excess of 10,000 minimal infective doses per gramme.

Once a standard is adopted it will be realised how much simpler the process of testing vaccine for potency becomes. To give an illustration: let us suppose that twenty animals are utilised for vaccine production to-day, the tissues from these animals are minced separately and pulped finely in the large Latapie apparatus, and are received into numbered containers. The appropriate amount of concentrated salt solution is added, and the tissues are placed in the cold store. The following morning they are removed from cold store, and the amounts of distilled water necessary to reduce salt concentration to normal, are added. They are then shaken on the shaking machine for fifteen or twenty minutes, and each lot is passed separately through the special screening centrifuge which is in use at the Laboratory. From each batch of tissue a small sample (1 c.c.) is now taken, and a series of dilutions is made until one reaches the stage where 1 c.c. of the dilution contains 1/10,000 of a gramme of the original pulped tissue. 1 c.c. of this 1/10,000 dilution from each batch of tissue is inoculated into a susceptible animal. The animals inoculated will be available for vaccine production as a rule in six days' time. To all the separate batches of vaccine the necessary quantity of formalin is now added, and they may be bottled straight away; this is an advantage as no handling of the product takes place after the formalin has been in contact with the tissues for any length of time, and in consequence there is very much less danger of bacterial infection of the product.

A weekly cycle can in this way be maintained between the testing of vaccine and the production of virus containing tissue. Compare this method with the older method of

inoculating graduated doses of a pooled vaccine into two or three animals and awaiting the result of protection tests in those animals. There is a saving in the cost of production corresponding to the value of the animals used for testing, and there is the added advantage that the vaccine is tested in batches from individual animals, and the tissues of any animal that is below standard can be discarded without wasting the remainder of the brew.

There are still two points to be considered; the safety of the vaccine with regard to possible production of Rinderpest, and its safety with regard to the possibility of accidental bacterial infection that might result in the production of abscesses. It is considered that improvements effected in the actual technique of handling the tissues, and in the adaptation of certain apparatus to our needs, largely eliminates any danger from either of these sources. It is, however, feasible to test pooled vaccine from a large number of brews upon susceptible animals, and the danger of accidental bacterial infection may be avoided by tests carried out upon small Laboratory animals such as mice, which are highly susceptible to the common infecting organisms.

(4) TRANSMISSION OF PROTOZOAN DISEASES THROUGH RINDERPEST DOUBLE INOCULATION.

The danger of transmitting haemozoan diseases by the inoculation of Rinderpest virus in the form of virulent blood has long constituted one of the most serious handicaps to the serum simultaneous method of Rinderpest immunization. To guard against this danger the Laboratory has undertaken the supply of "clean" virus makers, i.e. of animals that have never contracted Redwater or Anaplasmosis. These "clean" animals are used in all inoculations on farms where dipping is extensively practised. The animals themselves are obtained from certain dipped herds, and their blood is tested by inoculation into calves reared under tick-free conditions. The tested virus makers, i.e. those that have failed to transmit either Redwater or Anaplasmosis to tick-free calves, have in the past been infected before despatch to the field inoculators by subcutaneous inoculation of nasal discharge collected during the Rinderpest reaction from the ordinary Laboratory virus makers.

Recently field officers, who have been carrying out large numbers of double inoculations with such tested virus makers, have stated that while the blood of these animals has been perfectly safe for use upon susceptible stock up to the fifth

day, there has been evidence of the transmission of Redwater to susceptible cattle by blood taken on the seventh day of the reaction, and it has been inferred that the virus makers had contracted Redwater from the few blood cells contained in the nasal discharge used for the Rinderpest infection. It is practically impossible to exclude red cells from the nasal discharge used for inoculation, and in consequence some other method of infection was sought. At the same time Dr. Whitworth was asked to remove the spleens from two or three tested virus makers that had transmitted *Anaplasma* to susceptible calves, but not Redwater. The object was to ascertain whether it was possible that animals that had failed to transmit Redwater on one occasion to susceptible calves might, nevertheless, carry a latent infection, and might as a result of some intercurrent infection relapse to a point at which their blood became infective for animals susceptible to Redwater. Under the stress of splenectomy none of these animals broke down to Redwater, and the indications are that our method of testing these virus makers is adequate.

The osmotic pressure method of breaking down tissues during vaccine production—to which reference has already been made—at once suggested a means of obtaining virus free from any possible danger of infection by protozoa. It will be recalled that in tissue suspensions prepared by this method most of the virus is released from the cells during the process of breaking up, and that it is now possible to infect animals with dilutions of this material as high as one in ten thousand. A further point of interest is that in comparative tests of the liquid part of the vaccine and of the deposit thrown down by centrifuging, the former possessed the greater degree of immunizing power, and therefore one must conclude the greater amount of virus. In certain tests that were carried out spleen virus treated in this fashion was found to survive, apparently at full strength, for eight days when kept at cool room temperatures; no tests were carried out after longer periods. Here then, in the supernatant fluid after centrifuging, was material suitable for the infection of tested virus makers. As a further test a spleen containing enormous numbers of Redwater parasites was obtained and treated with a concentrated saline solution. After eighteen hours in the ice box the salinity was reduced to normal by the addition of distilled water. The material was shaken and allowed to stand for one hour. A quantity of the extract was then centrifuged, and large doses of the supernatant fluid were inoculated into six young animals known to be susceptible to

Redwater and Anaplasmosis. There were no reactions, and no infection resulted from the inoculation.

For several months past this method has been used for infecting any virus maker that may be required during the latter half of the week. It might be pointed out that the survival of virus in spleen extracts renders it possible to store virus in this form from one week's production until the next is ready. This property, however, has not been utilized to its fullest extent in view of the well known prejudice against aged virus; the longest period after which virus has been used for infection of field controls being three days. Animals required in the earlier part of the week have been infected by the inoculation of nasal discharge.

The preparation of such spleen extracts is not a matter of great difficulty, although if the virus is to be retained for more than twenty-four hours considerable care must be exercised to avoid any gross infection with organisms during its preparation. It is possible to obtain in this way, from a single spleen, something like 50,000 to 60,000 doses of virus suitable for use in double inoculation, and there is no risk of transmission of protozoan diseases even if the animal has been suffering from a heavy infection at the time of death.

EAST COAST FEVER.

By S. H. Whitworth.

During the period under review, Dr. S. H. Whitworth, Veterinary Research Officer, was instructed to carry out:—

- (1) Further investigations into the artificial transmission of East Coast Fever.
- (2) Dipping and hand-dressing of susceptible cattle to determine the efficacy of such in controlling East Coast Fever in a highly susceptible camp.

The following is a copy of this officer's report hereon.

(1) ARTIFICIAL TRANSMISSION OF EAST COAST FEVER.

During 1928 experiments were conducted to observe the comparative values in artificial East Coast Fever immunization by inoculation of cattle with—

(a) Spleen from an East Coast Fever reacting beast, taken early in the reaction (second day after first rise in temperature), followed seven days later by a second inoculation of spleen material taken late in the reaction, viz. just before death of the animal, and

(b) Spleen from an East Coast Fever reacting beast, taken late in the reaction, i.e. just before death.

In the experiments the material used in (b) was the same as that used for the second inoculation in (a).

The results may be summarized as follows :—

A. Of eight cattle inoculated according to (a)—

- (i) Two animals reacted East Coast Fever as a result of the inoculation and survived exposure.
- (ii) Two animals gave no temperature reaction to inoculation and survived East Coast Fever exposure, but eventually died of Anaplasmosis.
- (iii) One animal gave no reaction to inoculation but reacted and died of East Coast Fever on exposure.
- (iv) Two animals gave no temperature reaction to inoculation, but a temperature reaction on exposure, but with no Koch's bodies in gland smears, and survived.
- (v) One animal gave a temperature reaction to inoculation, but with no Koch's bodies in smears, and again a temperature reaction on exposure and again negative smears, and survived.

It should be noted that of those cattle which reacted to the inoculations, the time the reactions commenced after the inoculations indicated that these reactions resulted from the material injected at the second inoculation.

B. Of nine cattle inoculated according to (b)—

- (i) Two cattle reacted to the inoculation with gland smears showing Koch's bodies, and subsequently survived exposure. One of the two animals reacted again on exposure with smears positive East Coast Fever.
- (ii) One animal reacted to inoculation and died of East Coast Fever.
- (iii) Six animals gave no reactions to inoculation, and all six died of East Coast Fever on exposure.

Summary:

It would seem that although the material used for the second inoculation was the one which actually transmitted East Coast Fever, and which indeed gave rise to a fatal issue in one case, it was insufficient in itself to produce the required immunity in inoculated cattle for those cattle to survive exposure.

The better results were obtained in those cattle which received two inoculations, although the material used for the first inoculation did not actually produce any East Coast Fever reactions.

With a view to confirming or otherwise, the above results, similar experiments were made in 1929.

The following are the details of the experiments :—

Spleens used.

(a) No. 3438 taken twenty-four hours after commencement of the East Coast Fever reaction. *Smears* : Koch's bodies rare.

(b) No. 3100 taken late in the East Coast Fever reaction—just as Bovine No. 3100 appeared to be on the point of death. *Smears* : Koch's bodies numerous. *Theileria parva* numerous.

Cattle inoculated.

(a) Five cattle with Spleen 3438.

(b) Five cattle with Spleen 3438 and 3100 at seventeen days' interval between the two inoculations.

(c) Five cattle with Spleen 3100.

Method of inoculation.

Each animal was inoculated simultaneously with spleen material—

(a) 15 c.c. intravenously.

(a) 5 c.c. subcutaneously.

(c) An intradermal inoculation of as much material as can be forced into the skin. This is usually a very small amount.

Summary of Results.

(a) *Spleen 3438—inoculated cattle.*—None reacted to the inoculation and all reacted to East Coast Fever on exposure, four out of the five animals dying from East Coast Fever.

(b) *Spleen 3438—3100—inoculated cattle.*—Two out of the five cattle gave temperature reactions to the first (3438) inoculation, one showing Koch's bodies on smear examination. Both animals, however, reacted on exposure and died of East Coast Fever. The remaining three animals did not react to the inoculation but reacted and died of East Coast Fever on exposure.

(c) *Spleen* 3100—*inoculated cattle*.—All five cattle showed slight temperature reactions following the inoculation, but smears taken during the reactions were negative East Coast Fever. It is very doubtful that these reactions were East Coast Fever reactions. All five cattle reacted and died of East Coast Fever on exposure.

Discussion and Conclusions.

The infection of susceptible cattle and the conferring of immunity by means of injections with East Coast Fever infected spleen material, is followed by varying results. The best results in the past have been obtained by the inoculation of material showing Koch's bodies and *Theileria parva* numerous in smears. The above results, however, appear to indicate that some factor as yet not determined, but connected with the parasite itself in the spleen, may be responsible for the ultimate result. On the other hand it may be connected with the actual reception of the East Coast Fever parasite in the body of the inoculated animal. From past results, moreover, it does seem that better results are obtained in animals which have received more than one inoculation.

Again, it may be the case that the actual number inoculated, of a particular stage of development of the East Coast Fever parasite in the spleen, is the factor. This number may depend on the vitality of the parasite outside the animal body.

In the experiments described, the question of susceptibility of the inoculated animals does not arise since the mortality from East Coast Fever was ultimately fourteen out of fifteen cattle on experiment, i.e. 96 per cent.

To compare artificial transmission of East Coast Fever with that of such diseases as Redwater, Anaplasmosis, Heartwater and Gonderia mutans infections, the following observations might be considered.

Anaplasma parasites remain in the blood stream of recovered animals probably for life, and can readily be transmitted by blood inoculation. The parasites are comparatively resistant for some time outside the animal body, and are capable of cultivation on artificial media. The same remarks apply to Gonderia mutans, except that this parasite, as yet, has not been cultivated on artificial media.

Redwater parasites can be transmitted from a recovered Redwater infected animal for only a limited period after recovery of the animal from the infection, and with greater

certainly soon after the Redwater reaction. This power of transmission gradually decreases until the Redwater recovered animal fails to transmit entirely. The Redwater parasite is not very resistant to injury outside the animal body.

Heartwater is transmissible artificially with a certain amount of difficulty and the parasite is very easily killed outside the animal body. So far as is known, recovered animals do not transmit the infection.

By comparison with the above-mentioned infections, it would seem possible that the liability of the transmitting stage of the East Coast Fever parasite may be a factor responsible for artificial infection and conferring of immunity. And if the transmitting stage is not present in great numbers in the inoculated material, one has to consider that death of the particular stage may occur either outside the body, or in the inoculated animal before infection takes place.

If the stages of development of the East Coast Fever parasite, both in the tick and in the animal body, were definitely known, more conclusive results on artificial infection and immunity might be obtained.

(2) DIPPING AND HAND-DRESSING EXPERIMENTS.

Observations on Exposure of Cattle to East Coast Fever Infection.

Experiments were undertaken to determine whether or not cattle could be passed through a highly infected East Coast Fever camp without becoming infected with the disease by means of ticks; when they were allowed to remain in the camp for periods of less than seventy-two hours, and dipped and hand-dressed immediately on removal from the camp. The actual periods of exposure were fifty-nine hours, sixty-five hours and seventy-one hours.

Observations were made on (a) cattle which had been previously dipped and hand-dressed, and (b) on cattle which had not previously been dipped and hand-dressed. To each series of animals was added a control beast which was left untreated on removal from the East Coast Fever camp.

The cattle used on the experiment were those discontinued from other laboratory experiments, and considered to be susceptible to East Coast Fever infection. The history of each animal at the Laboratory prior to being put on experiment is indicated in the tabulated sheet. The hand-dressing mixture consisted of an emulsion of hard soap, 1 lb.; soft

water, 1 gallon; and paraffin, 4 gallons. This mixture, which is an 80 per cent stock emulsion, was then diluted with water to make a 30 per cent emulsion.

The hand-dressing was carried out by throwing the animals and applying the emulsion, with the aid of a spray pump, to the insides of the ears, under the tail, around the eye-lids, and on the external genitals of males. The brushes of the tails were removed by clipping before applying the emulsion. The fluid in the dipping tank was 12 per cent above normal three-day strength for the earlier dipping periods.

Immediately prior to exposure, those cattle under (a), previously dipped and hand-dressed, were dipped twice in succession in dipping fluid 19 per cent above three-day strength and then thoroughly hand-dressed as indicated above. This treatment was repeated in all cases where dipping and hand-dressing was carried out immediately *after* removal from the East Coast Fever camp, but the cattle were not de-ticked, but were removed to clean fenced bomas A and B; the lot which were dipped and hand-dressed after exposure being put into boma A, and the undipped lot into boma B. All animals were on daily morning temperatures, and all reactions controlled by smear examinations. The following are the details of the experiments.

(a) Cattle previously dipped and hand-dressed.

1. *Exposure for fifty-nine hours.*

Bovines Nos. 2812 and 2828 exposed to infection for fifty-nine hours, then dipped and hand-dressed and put in boma A.

Result.—No. 2812 showed no reaction, and this animal was subsequently found to be immune to East Coast Fever. No. 2828 reacted and died of East Coast Fever.

Control.—Bovine No. 3010 was exposed as above but was left untreated after removal from the camp, and then transferred to boma B.

Result.—This animal reacted and died of East Coast Fever.

2. *Exposure for sixty-five hours.*

Bovines Nos. 1989 and 2425 exposed to infection for sixty-five hours, then dipped and hand-dressed and transferred to boma A.

Result.—Bovine 1989 showed no reaction, and was subsequently found to be susceptible to East Coast Fever.

Bovine 2426 showed no reaction, and was subsequently found to be immune to East Coast Fever.

Control.—Bovine No. 3285 exposed as above, but left untreated after removal and put into boma B.

Result.—This animal reacted and died of East Coast Fever.

3. *Exposure for seventy-one hours.*

Bovines Nos. 2432 and 3071 exposed to infection for seventy-one hours, then dipped and hand-dressed and transferred to boma A.

Results.—Bovine 2432 reacted to East Coast Fever and recovered. Bovine 3071 reacted and died of East Coast Fever.

Control.—Bovine No. 3385 exposed as above, but left untreated after removal, and put into boma B.

Result.—This animal reacted and died of East Coast Fever.

Summary.

1. *Fifty-nine hours' exposure.*—Of two dipped animals exposed to infection for fifty-nine hours, one proved immune, and the other reacted and died of East Coast Fever.

2. *Sixty-five hours' exposure.*—Of two dipped animals exposed to infection for sixty-five hours, one proved to be immune, and the other failed to become infected, and was subsequently proved to be susceptible.

3. *Seventy-one hours' exposure.*—Of two dipped animals exposed to infection for seventy-one hours, both reacted, followed in one case by recovery, and by death in the other.

4. All the control animals reacted and died of East Coast Fever.

(b) *Cattle not previously dipped and not hand-dressed.*

Exposure for fifty-nine hours.

Bovine No. 3512 exposed to infection for fifty-nine hours, then dipped and hand-dressed and removed to boma A.

Result.—Reacted and died of East Coast Fever.

Control.—Bovine No. 3523 exposed as above, but left untreated after removal from East Coast Fever camp, then put in boma B.

Result.—Reacted and died of East Coast Fever.

Exposure for sixty-five hours.

Bovine No. 3256 exposed to infection for sixty-five hours, then dipped and hand-dressed, and removed to boma A.

Result.—Reacted and died of East Coast Fever.

Control.—Bovine No. 3530 exposed as above but left untreated after removal from East Coast Fever camp, then put into camp B.

Result.—Reacted and died of East Coast Fever.

Exposure for seventy-one hours.

Bovine No. 3561 exposed to infection for seventy-one hours, then dipped and hand-dressed and put into camp A.

Result.—Reacted and died of East Coast Fever.

Control.—Bovine No. 3565 exposed as above, but left untreated after removal from East Coast Fever camp, then put into boma B.

Result.—Reacted and died of East Coast Fever.

Summary.

1. Of three cattle, Nos. 3512, 3256 and 3561, previously undipped and exposed to infection for fifty-nine hours, sixty-five hours and seventy-one hours respectively, and hand-dressed and dipped after exposure, all three reacted and died of East Coast Fever.

2. All control animals reacted and died of East Coast Fever.

Conclusion.

Cattle, either dipped and hand-dressed or undipped and hand-dressed, prior to exposure to infection for periods of fifty-nine hours, sixty-five hours and seventy-one hours, and then subsequently dipped and hand-dressed, can become infected with East Coast Fever. In our experiments the exposure was extremely severe, and of those animals which were found susceptible to East Coast Fever, viz. thirteen head, only one animal, or 12 per cent, escaped infection.

It is obvious, therefore, that the process of dipping and hand-dressing as indicated in the experiments, did not kill 100 per cent of infected ticks. The period necessary for an infected tick to feed before transmitting infection is at least seventy-two hours.

During the process of dipping and hand-dressing which was carried out every three days subsequent to the exposure, in order to prevent dissemination of ticks at the Laboratory, it was noted that living ticks were present on all cattle for several days after exposure.

EAST COAST FEVER, DIPPING AND HAND-DRESSING EXPERIMENTS.

Laboratory No. of Bovine on experiment	Previous history of dippings and hand-dressings to time of exposure to infection	Dipped and hand-dressed immediately to natural exposure	Date and time of exposure to natural infection	Date and time of removal from exposure to infection	Duration of exposure	Dipped and hand-dressed immediately on removal	Dipped and hand-dressed every 3 days after removal	Date of commencing re-action to E.C.F.	Result
X2812	14.4.28- 24.4.28 Dipped every 3 days 24.4.28- 3.5.28 Exp. 1952. Not dipped. 3.5.28- 22.8.28 To Farm R, Immunity test. Not dipped. 22.8.28- 5.9.28 Exp. 1952. Not dipped. 5.9.28-12.11.28 D. Dipped every 3 days. 12.11.28- 11.1.29 Exp. 2000 P.P. Not dipped. 11.1.29- 4.2.29 D. Dipped every 3 days. 4.2.29- 3.3.29 Exp. 2015. Not dipped. 3.3.29- 30.3.29 Dipped and hand-dressed every 3 days. 30.3.29 Dipped and hand-dressed prior to exposure.	Yes	30-3-29 at 6 p.m.	2-4-29 at 5 a.m.	59 hours	Yes	Yes	..	Shown no reaction
X2828	14.4.28- 9.5.28 Dipped every 3 days. 9.5.28- 31.5.28 Serum test. Not dipped. 31.5.28- 5.7.28 D. Dipped every 3 days. 5.7.28- 20.2.29 L.L.D. Not dipped. 20.2.29- 13.3.29 Exp. 2015. Not dipped. 13.3.29- 30.3.29 D. and Exp. 2042. Dipped every 3 days. 30.3.29 Dipped and hand-dressed prior to exposure.	Yes	30-3-29 at 6 p.m.	2-4-29 at 5 a.m.	59 hours	Yes	Yes	17-4-29	Reacted and died of East Coast Fever Treatment 20-4-29.
X3010	18.9.28-12.10.28 Dipped every 3 days. 12.10.28-31.10.28 Rinderpest control. Not dipped. 31.10.28-12.11.28 D. Dipped every 3 days. 12.11.28- 11.1.29 Exp. 2000. Not dipped. 11.1.29- 18.3.29 D. Dipped every 3 days. 18.3.29- 30.3.29 Dipped every 3 days. 30.3.29 Dipped and hand-dressed prior to exposure.	Yes	30-3-29 at 6 p.m.	2-4-29 at 5 a.m.	59 hours	No	No	14-4-29	Reacted and died of East Coast Fever on 22.4.29

See
Footnote
(1)
to East Coast
Fever

EAST COAST FEVER, DIPPING AND HAND-DRESSING EXPERIMENTS—(Contd.).

Laboratory No. of Bovine on experiment	Previous history of dippings and hand-dressings to time of exposure to infection	Dipped and hand-dressed immediately to exposure	Date and time of exposure to natural infection	Date and time of removal from exposure to infection	Duration of exposure	Dipped and hand-dressed immediately on removal	Dipped and hand-dressed every 3 days after removal	Date of commencing action to E.C.F.	Result
X1989	10-8-27- 10-9-27 (3-day dipping) dipped. 10-9-27-24-10-27 Rinderpest control. Not dipped. 24-10-27- 7-9-28 D. Dipped. 7-9-28 - 13-9-28 Not dipped. 13-9-28-12-10-28 D. Dipped. 12-10-28-12-11-28 Not dipped. 12-11-28- 11-1-29 D. Dipped 11-1-29- 30-3-29 Exp. 2042. Dipped. 30-3-29 Dipped and hand-dressed prior to exposure.	Yes	30-3-29 at 6 p.m.	2-4-29 at 11 a.m.	65 hours	Yes	Yes	..	Shown no reaction to East Coast Fever. <i>See footnote (2)</i>
X2426	2-11-27- 6-9-28 Dipped every 3 days. 6-9-28- 13-9-28 Rinderpest control. Not dipped. 13-9-28-12-10-28 Blackquarter vaccine. Not dipped. 12-10-28-12-11-28 D. Dipped every 3 days. 12-11-28- 11-1-29 Exp. 2000 P.P. Not dipped. 11-1-29- 30-3-29 Dipped every 3 days. 30-3-29 Dipped and hand-dressed prior to exposure.	Yes	30-3-29 at 6 p.m.	2-4-29 at 11 a.m.	65 hours	Yes	Yes	..	Shown no reaction to East Coast Fever. <i>See footnote (3)</i>
X3285	19-12-28- 7-1-29 Dipped every 3 days. 7-1-29- 18-2-29 Rinderpest control. Not dipped. 18-2-29- 30-3-29 Dipped every 3 days. 30-3-29 Dipped and hand-dressed prior to exposure.	Yes	30-3-29 at 6 p.m.	2-4-29 at 11 a.m.	65 hours	No	No	16-4-29	Reacted and died of East Coast

EAST COAST FEVER, DIPPING AND HAND-DRESSING EXPERIMENTS—(Contd.).

Laboratory No. of Bovine on experiment	Previous history of dippings and hand-dressings to time of exposure to infection	Dipped and hand-dressed immediately to exposure	Date and time of exposure to natural infection	Date and time of removal from exposure to infection	Duration of exposure	Dipped and hand-dressed immediately on removal	Dipped and hand-dressed every 3 days after removal	Date of commencing reaction to E.C.F.	Result
X2432	22-11-27- 6-9-28 Dipped every 3 days, 6-9-28- 13-9-28 Rinderpest exp. Not dipped, 13-9-28-12-10-28 Exp. 1985. Not dipped, 12-10-28-12-11-28 Dipped every 3 days, 12-11-28- 11-1-29 P.P. exp. Not dipped, 11-1-29- 13-2-29 Dipped every 3 days, 13-2-29- 1-3-29 Exp. 2015, Not dipped, 1-3-29- 30-3-29 Exp. 2042, Dipped every 3 days, 30-3-29 Dipped and hand-dressed prior to exposure.	Yes	30-3-29 at 6 p.m.	2-4-29 at 5 p.m.	71 hours	Yes	Yes	15-4-29	Reacted to E.C.F. and recovered.
X3071	24-10-28-12-12-28 Dipped every 3 days, 12-12-28-27-12-28 Rinderpest exp. Not dipped, 27-12-28- 30-3-29 Exp. 2042, Dipped every 3 days, 30-3-29 Dipped and hand-dressed prior to exposure.	Yes	30-3-29 at 6 p.m.	2-4-29 at 5 p.m.	71 hours	Yes	Yes	15-4-29	Reacted to E.C.F. Died of E.C.F. 23-4-29.
X3385	18-1-29- 31-1-29 Dipped every 3 days, 31-1-29- 18-2-29 Rinderpest exp. Not dipped, 18-2-29- 20-3-29 Dipped every 3 days, 20-3-29- 30-3-29 Exp. 2042, Dipped every 3 days, 30-3-29 Dipped and hand-dressed prior to exposure.	Yes	30-3-29 at 6 p.m.	2-4-29 at 5 p.m.	71 hours	Untreated	Untreated	12-4-29	Reacted and died of East Coast on 19-4-29.

EAST COAST FEVER, DIPPING AND HAND-DRESSING EXPERIMENTS—(Contd.).

Laboratory No. of Bovine on experiment	Previous history of dippings and hand-dressings to time of exposure to infection	Dipped and hand-dressed immediately to exposure	Date and time of exposure to natural infection	Date and time of removal from exposure to infection	Duration of exposure	Dipped and hand-dressed immediately on removal	Dipped and hand-dressed every 3 days after removal	Date of commencing re-action to E.C.F.	Result
X3512	25-2-29- 15-3-29 Rinderpest control, dipped. 15-3-29- 18-3-29 D. Dipped. 18-3-29- 30-3-29 Not dipped. 30-3-29 Untreated to time of exposure.	No	30-3-29 at 6 p.m.	2-4-29 at 5 a.m.	59 hours	Yes	Yes	13-4-29	Reacted and died of East Coast Fever on 26-4-29
X3523	25-2-29- 15-3-29 Rinderpest control, dipped. 15-3-29- 18-3-29 Dipped every 3 days. 18-3-29- 30-3-29 Exp. 2042. Not dipped. 30-3-29 Untreated to time of exposure.	No	30-3-29 at 6 p.m.	2-4-29 at 5 a.m.	59 hours	No	No	14-4-29	Reacted and died of East Coast Fever on 24-2-29
X3526	20-3-29- 30-3-29 Untreated. 30-3-29 Untreated to time of exposure.	No	30-3-29 at 6 p.m.	2-4-29 at 11 a.m.	65 hours	Yes	Yes	14-4-29	Reacted and died of East Coast Fever on 19-4-29
X3530	22-2-29- 15-3-29 Not dipped. 15-3-29- 20-3-29 D. Dipped every 3 days. 20-3-29- 30-3-29 Not dipped. 30-3-29 Untreated to time of exposure	No	30-3-29 at 6 p.m.	2-4-29 at 11 a.m.	65 hours	No	No	14-4-29	Reacted and died of East Coast Fever on 16-4-29

EAST COAST FEVER, DIPPING AND HAND-DRESSING EXPERIMENTS—(Contd.).

Laboratory No. of Bovine on experiment	Previous history of dippings and hand-dressings to time of exposure to infection	Dipped and hand-dressed immediately to exposure	Date and time of exposure to natural infection	Date and time of removal from exposure to infection	Duration of exposure	Dipped and hand-dressed immediately on removal	Dipped and hand-dressed every 3 days after removal	Date of commencing re-action to E.C.F.	Result
X3561	22-2-29- 25-2-29 Dipped every 3 days. 25-2-29- 15-3-29 Rinderpest exp. Not dipped. 15-3-29- 30-3-29 Exp. 2042. Not dipped.	No	30-3-29 at 6 p.m.	2-4-29 at 5 p.m.	71 hours	Yes	Yes	14-4-29	Reacted and died of East Coast Fever on 22-2-29
X3565	22-2-29- 25-2-29 Dipped every 3 days. 25-2-29- 15-3-29 Rinderpest exp. Not dipped. 15-3-29- 30-3-29 Not dipped to time of exposure.	No	30-3-29 at 6 p.m.	2-4-29 at 5 p.m.	71 hours	Untreated	Untreated	12-4-29	Reacted and died of East Coast Fever on 23-4-29

REMARKS.—(1) Subsequently exposed in E.C.F. camp for several months and found immune.

(2) Contracted and died of East Coast Fever when subsequently exposed in East Coast Fever camp.

(3) Animal proved immune when subsequently tested on immunity by prolonged exposure (several months) in E.C.F. camp.

REDWATER, ANAPLASMOSIS AND GONDERIA MUTANS.

By S. H. Whitworth.

The following observations on Redwater, Anaplasmosis and Gonderia mutans infections were made by Dr. S. H. Whitworth, Veterinary Research Officer.

These observations were made having special regard to the detection of animals which had recovered from one or more of these infections.

During experiments carried out in 1928 on observations on splenectomy in relation to East Coast Fever, it was noted that all animals which had recovered from Redwater, showed a recurrence of the parasites in the blood shortly after the operation. The following experiments were therefore carried out to make closer observations on splenectomized bovines.

Five cattle, Nos. 3520, 3538, 4112, 4069 and 4079, which had recovered from Redwater-Anaplasmosis and Gonderia mutans infections were splenectomised, as also was one control animal, No. 2978, which had been proved to transmit Gonderia mutans to a newly-born calf, but not Redwater and Anaplasmosis. This particular animal was previously used as a clean tested virus maker for Rinderpest double-inoculations.

Results.

The five Redwater-Anaplasmosis-Gonderia mutans-recovered cattle showed a recrudescence of Redwater parasites in the blood stream within seventy-two hours, with elevated temperature, the parasites increasing in numbers rapidly, and to such an extent that the animals received a therapeutic dose of *Trypanblue* to prevent a possible mortality. The Anaplasma breakdowns were not so severe; indeed, the parasites were in most cases rather rare.

Gonderia mutans appeared in the blood cells in enormous numbers in all cases, the picture closely resembling one of blood infection with *Theileria parva* (E.C.F.), except for the absence of Koch's bodies. All five animals showed symptoms of acute anaemia, and considerable loss of condition.

The control animal (2978) on the other hand, showed no parasites of Redwater and Anaplasmosis in blood over a period of 116 days. A breakdown to Gonderia mutans infection, however, occurred, these parasites being present in enormous numbers for a period of two-and-a-half months after the

animal was splenectomized. Apart from symptoms of anaemia and slight temperature reaction, no other symptoms were observed, and the animal kept in good condition throughout.

Conclusions.

1. In Redwater-Anaplasmosis recovered cattle (five in experiment) breakdowns to these infections occurred in 100 per cent of cases. The Redwater breakdowns were much more severe than the Anaplasmosis breakdowns.

2. *Gonderia mutans* breakdowns occurred in 100 per cent of splenectomized cattle (six in experiment).

3. With regard to *Gonderia mutans*, no bodies resembling Koch's bodies were observed in any case, although gland smears were examined every day over a considerable period.

4. From the results obtained it would appear that the spleen in its relation to Redwater immunity resembles that with which it is associated in *Gonderia mutans* immunity.

5. We have as yet, in this Colony, no evidence that the parasites *Gonderia mutans* has, as a stage in its development in the animal body, a parasite resembling the Koch's body of East Coast Fever.

The statement made by Theiler and Graf (see thirteenth and fourteenth Annual Reports of the Director of Veterinary Education and Research, Onderstepoort, page 69), that *Gonderia mutans* is really a *Theileria* which has a stage in its development which cannot be distinguished microscopically from the Koch's body of East Coast Fever has not, as yet, been confirmed in Kenya.

The details of the experiments with the results obtained, are shown in the accompanying table, p. 239.

SPLENECTOMY IN RELATION TO REDWATER, ANAPLASMOSIS AND GONDERIA MUTNAS INFECTIONS.

Lab. No. of bovine experiment	Recovered from Redwater anaplasmosis	Date of splenectomy	Date first showing P. bigemini	Date of inoculation with Trypanblue	Date first showing Ana-plasma	Interval between Splenectomy and first showing		Gonderia mutans breakdown ?	Remarks
						(a) P. bigemini	(b) Anaplasma		
X2978	No	16-8-29	..	..	..	..	..	Yes, with parasites very frequent, but no clinical symptoms except anaemia.	This animal was a tested clean virus-maker and used for Rinderpest double inoculation.
X3520	Yes	13-8-29	16-8-29	17-9-29 P. bigemini frequent	5-9-29	3 days	23 days	Yes severe.	Acute anaemia, animal lost condition.
X3538	Yes	14-8-29	16-8-29	18-8-29 P. bigemini frequent	23-8-29	2 days	9 days	Yes severe.	Acute anaemia, animal lost condition. Anaplasma parasites when present were rare.
X4112	Yes	16-8-29	19-8-29	22-8-29 P. bigemini frequent	21-8-29	3 days	5 days	Yes severe.	Anaplasma parasites were rare till 18-10-29 when they were frequent.
X4069	Yes	15-8-29	18-8-29	22-8-29 P. bigemini frequent	21-8-29	3 days	6 days	Yes severe.	Anaplasma parasites were numerous, especially on and after the tenth day after splenectomy.
X4079	Yes	14-8-29	16-8-29	18-8-29 P. bigemini frequent	3-9-29	2 days	20 days	Yes severe.	Anaplasma frequent on and after the twentieth day after splenectomy.

PLEURO-PNEUMONIA CONTAGIOSA BOVUM.

(LUNG SICKNESS OF CATTLE.)

(By J. Walker.)

Prophylactic vaccination experiments with formalised inactivated tissue extract.

The accidents which sometimes occur as the result of inoculation of Pleuro-pneumonia virus, particularly from a naturally infected beast, for preventive inoculation purposes, are difficult to avoid and are sometimes serious; even with virus which is attenuated by culture and which is largely issued by this Laboratory, a small percentage of mortality may occur. It is impossible to confer an immunity without the risk of some losses consequent on the extension of the virus from the site of inoculation up the tail and invasion of the pelvis.

The possibility of preparing an *inactivated* vaccine by treatment of the minced reacting tissues of an experimentally inoculated animal with commercial formalin was investigated; the method of preparing the formalised material was as follows :—

Cattle reacting severely to the subcutaneous inoculation of a virulent virus were slaughtered and the pleuro-pneumonia "tumour" excised and minced in a No. 4 mincer. The minced tissues were then mixed with normal saline in the proportion of three of saline to one of tissue and the mixture placed in the ice cabinet at approximately 1° C. overnight. The mixture was then filtered through muslin and (1) commercial formalin (38.1 per cent. Formaldehyde) added to one-half of the total bulk so as to make 1 per cent of the bulk, (2) and to the other half commercial formalin so as to make one-half per cent of the bulk. Both mixtures were placed in the ice cabinet for twenty-two days at 1° C. then used to experimentally inoculate cattle.

The details of the experimental inoculation and the results are shown in the following table :—

PLEURO-PNEUMONIA CONTAGIOSA BOVUM.
EXPERIMENTS WITH INACTIVATED FORMALINIZED TISSUE EXTRACT.
3% FORMALINIZED TISSUE EXTRACT.

Cattle No.	Site of Inoculation	Dose	Date of 1st Inoculation	Date of 2nd Inoculation	Date of 3rd Inoculation	Total Dose	Result of Inoculation	Date of immunity test with 5th, 6th and 7th generation sub-cultures of virus from a naturally infected beast	Dose	Site of Inoculation	Result
5082 5126 5125 5132	Left shoulder	5 c.c. 10 c.c. 15 c.c. 20 c.c.	11-1-30	18-1-30	25-1-30	15 c.c. 30 c.c. 45 c.c. 60 c.c.	No reaction to Pleuro-pneumonia.	15-2-30	5 c.c.	Left shoulder	Severe reaction 12" x 12" Severe reaction 15" x 15" Slight reaction. Died from external cause Severe reaction 15" x 15"
5159 4602 5163	Left shoulder	25 c.c. 30 c.c. 35 c.c.	11-1-30	18-1-30		50 c.c. 60 c.c. 70 c.c.		8-2-30	5 c.c.	Left shoulder	No reaction. " " Severe reaction 12" x 12"
5160 5153 5156	Left shoulder	40 c.c. 45 c.c. 50 c.c.	11-1-30			40 c.c. 45 c.c. 50 c.c.		1-2-30	5 c.c.	Left shoulder	Severe reaction (destroyed in extremis 19-2-30). Marked reaction 9" x 9" Severe reaction (destroyed in extremis 18-2-30).

PLEURO-PNEUMONIA CONTAGIOSA BOVUM.—(Contd.).
EXPERIMENTS WITH INACTIVATED FORMALINIZED TISSUE EXTRACT.
1% FORMALINIZED TISSUE EXTRACT.

Cattle No.	Site of Inoculation	Dose	Date of 1st Inoculation	Date of 2nd Inoculation	Date of 3rd Inoculation	Total Dose	Result of Inoculation	Date of immunity test with 5th, 6th and 7th generation sub-cultures of virus from a naturally infected beast	Dose	Site of Inoculation	Result
5151	Left shoulder	5 c.c.	11-1-30	18-1-30	25-1-30	15 c.c.	No reaction to Pleuro-pneumonia	15-2-30	5 c.c.	Left shoulder	No reaction.
5176		10 c.c.				30 c.c.					Severe reaction 12" × 12"
5087		15 c.c.				45 c.c.					Marked reaction 6" × 6"
5145		20 c.c.				60 c.c.					" "
5154	Left shoulder	25 c.c.	11-1-30	18-1-30	..	50 c.c.		8-2-30	5 c.c.	Left	No reaction.
5137		30 c.c.				60 c.c.					" "
5167		35 c.c.				70 c.c.					Severe reaction 12" × 12"
5142	Left shoulder	40 c.c.	11-1-30	..	..	40 c.c.		1-2-30	5 c.c.	Left shoulder	Severe reaction (destroyed in extremis 19-2-30).
5149		45 c.c.				45 c.c.					Severe reaction 15" × 15"
5122		50 c.c.				50 c.c.					" " 12" × 12"

CONTROL FOR STRAIN OF VIRUS USED IN EXPERIMENT.

Cattle Nos.	Site of Inoculation	Dose	Date of Inoculation	Result
4947	Left shoulder	5 c.c. of 1st generation culture.	14-12-29	Severe reaction. Died 7-1-30.
4933				Severe reaction.
4931				Severe reaction (destroyed in extremis, 7-1-30).
4917				Severe reaction, (destroyed in extremis, 2-1-30).
4882				Marked reaction 9" × 9"
4893				Died 4 days after inoculation (external cause).

Summary.

Of ten cattle inoculated subcutaneously behind the shoulder with one-half per cent Formalinized Pleuro-Pneumonia tumour extract, three and two injections at seven days' intervals, and a single injection respectively, the total dosage varying from 15 to 70 c.c., and twenty-one days later tested on their immunity with a slightly attenuated virus (five, six and seven generations of sub-culture), six reacted severely, (two of which were destroyed in extremis), one reacted markedly, one reacted slightly (and died of an external cause), and two did not react.

Of ten cattle inoculated subcutaneously behind the shoulder with 1 per cent Formalinized Pleuro-pneumonia tumour extract, three and two injections at seven days' interval, and a single injection respectively, the total dosage varying from 15 to 70 c.c., and twenty-one days later tested on their immunity with a slightly attenuated virus (five, six and seven generations of sub-culture), five reacted severely (one of which was destroyed in extremis), two reacted markedly, and three did not react.

The same strain of virus, but of the first generation of culture, when inoculated behind the shoulder to cattle which were not experimentally inoculated with formalinized tumour tissue extract, produced 100 per cent of severe reactions with some mortality.

Conclusions.

Inactivated formalinized Pleuro-pneumonia tumour tissue extract confers little if any protection against a severe reaction with some mortality to subcutaneous inoculation of a dose of virus which has been slightly attenuated by sub-culture. It would appear from the results that some protection was given, taking into consideration that some of the vaccinated cattle did not react, but it is the experience that a percentage of susceptible cattle may not react to behind the shoulder inoculation with a virus which has been attenuated by subculture.

NAIROBI QUARANTINE DISEASE.

(By R. W. M. Mettam.)

Introduction.

Owing to the prevalence of tick-borne diseases in Kenya, which take a heavy annual toll of pure bred animals, a quarantine station has been established near Nairobi, where

imported pedigree stock is admitted as soon as possible after landing at Mombasa and there immunised against Redwater and Anaplasmosis by artificial means.

The quarantine station is situated on the Athi plains, some two miles from the centre of Nairobi, at mile 1/16 on the Nairobi-Thika railway line. It can accommodate some seventy cattle as well as smaller animals, e.g. dogs and cats, all of which are under the professional supervision of the District Veterinary Officer, who is assisted by a white stock inspector and a gang of trained natives.

The cattle in the quarantine are pure bred pedigree stock, of both sexes, which have just reached the proper breeding age. They comprise many breeds, e.g. Shorthorn, Red Poll, Friesian, Blue Albion, Welsh, Ayrshire, etc. They are all imported from the British Isles, though in 1928 some few arrived from South Africa. They had thus experienced a long and trying sea voyage under a variety of climatic and hygienic conditions, for it can by no means be accepted that the hygiene of animal transport by sea is yet ideal. The majority of the animals when they arrived in Nairobi were very foot-sore and out of condition, so that it was necessary to nurse them back to health before immunising them against Redwater and Anaplasmosis.

Previous to the beginning of 1929, when the serious mortality occurred which led up to the present investigation, the health of the cattle in the quarantine had given no reason for anxiety, though during 1928 some deaths had taken place, all of which, except two, were attributed to Anaplasmosis. The two exceptions were diagnosed as "snake-bite" and "*bacillary necrosis*" respectively, but there is no doubt, judging from post-mortem research, that both these deaths were really due to the same fatal condition which caused so much loss during the early months of 1929.

It may be added for the information of those who are not familiar with the objects of the Redwater-Anaplasmosis vaccination, that owing to the prevalence of tick-borne diseases in the settled areas of Kenya, it is necessary to inoculate all imported cattle against the two diseases, Redwater and Anaplasmosis, for which purpose an effective vaccine has been devised. This inoculation is preferably done in one centre, under the supervision of a professional officer because the reactions may be very violent in highly susceptible imported cattle and a certain percentage die if they are not

carefully nursed and treated, in the case of Redwater, with *Trypanblue*; at the crisis of the reaction. The vaccine for immunisation is blood obtained from bovines which have recovered from the disease and are called "vaccine producers." These animals are kept at the Veterinary Laboratory, Kabete, some ten miles distant from the quarantine. When cattle are ready for immunisation the donors are bled and their blood is inoculated into the pedigree stock with the least possible delay. The reaction to the vaccines, for two are given at intervals of fifty to seventy days, should be finished in one hundred days or so. Occasionally when the Redwater-Anaplasmosis reaction has subsided, the animal, before being returned to the owner, is inoculated with the new anti-Rinderpest vaccine, which takes some three weeks, and even with Anthrax and Blackquarter vaccines. It will be seen, therefore, that an animal is very lucky if it is in the quarantine under one hundred days. Instances are known where animals have been kept in the quarantine for four to five months, but these are exceptional.

Attention must now be paid to the diet of the animals undergoing immunisation. Each animal is fed daily on 18 lb. of dried lucerne and 4 lb. each of bran and crushed maize. A block of salt for "lick" is provided, while pure fresh water is liberally supplied, the source of which is from the Nairobi reservoir at Kikuyu. It is not practical to obtain newly cut grass as there is a real danger of introducing ticks into the quarantine and so setting up a epizootic of Heartwater or East Coast Fever, but whenever possible, especially in the case of animals reacting severely to the vaccination, fresh green maize tops are added to the diet, but these cannot always be obtained. The lucerne (*Medicago sativa*) is obtained in large quantities from Manera Farm, Naivasha.

Here it is grown along the lake littoral, cut when ready, sun dried and sent out in 1 cwt. bales. It always appeared very sound, free from moulds, etc., and from adventitious herbage. The possibility of damaged lucerne as the cause of quarantine fatalities will be considered later in this paper, but it may be pointed out here that large quantities of lucerne from Naivasha are used as a supplementary feed to the Laboratory stock and on many farms throughout the country, and there has never been the slightest suspicion that it is responsible for any sickness.

Finally, it may be mentioned that the health of the non-bovine inmates at the quarantine was excellent at the time the cattle were affected with the disease under review.

Symptomology, Course and Mortality.

The onset of the disease was very insidious. The first indication that something was wrong was the appearance of red haemorrhages in the skin and on the visible mucosae. The cutaneous haemorrhages were best seen on the sparsely haired or naked areas of the body, e.g. scrotum, or mammary glands, perineum, anus, muzzle, ears, medial aspect of the thighs, etc. Careful examination, however, showed that similar haemorrhages were generally present all over the body.

At first the haemorrhages were small, painless and uniform in size, about .25 to 1 cm. in diameter. They were red in colour, not dissipated by pressure, and projected above the general level of the skin, giving it a "lumpy" feeling. As the disease progressed they became purplish and, in the cases recovered under treatment, the skin finally became a dirty yellow colour. These haemorrhages were succeeded by the formation of nodules which gave a rough appearance to the skin as observed in dry eczema. Pathologically all these changes arose in connexion with the hair follicles in which the haemorrhages occurred and causing them to swell and form the characteristic nodules which were so noticeable on the skin. At the same time there was an exudation of the straw-coloured fluid from the follicles on to the surface. This readily dried and formed a scurfy deposit which made the skin very dirty. Simultaneous with the appearance of the cutaneous haemorrhages, petechiae or extravasation of the blood were observed on all the visible mucosae, viz. anal, conjunctival, schneiderian and buccal. While the mucosae themselves were generally moist and pale, the haemorrhages varied greatly in size, number and distribution. They were comparatively rare in the buccal cavity and often only noticed on or under the tongue where they formed blotches or on the mucosae of the gums, cheeks or lips. In the nasal chamber they were few and large, or numerous and miliary, so that the membrane appeared as if sprinkled with blood. Epistaxis was always noticed and sometimes profuse, especially in the last phases of the disease. The animal in trying to clear its respiratory passages blew out the blood and the ropey catarrhal material in its nose and literally besprinkled its surroundings with blood. Finally scleral and

conjunctival haemorrhages were often present. They were few in numbers red in colour and lenticular in shape, averaging up to 1 cm. along their greatest axis.

When these symptoms first appeared the animal showed systemic disturbances. Its coat was dry and harsh. There was more or less complete anorexia, salivation, cessation of rumination, lactation and other symptoms of acute malaise. Its respirations were increased up to eighty per minute and were accompanied by grunting, groaning and grinding of the teeth, or they were of a blowing nature. Coughing was generally noticed. The animal lay down and looked very ill, but it often stood with its head lowered, back slightly arched and most unwilling to move.

At first there was obstinate constipation, but after a few days blood was noticed in the faeces. In some cases this was the first symptom of the illness and preceded the appearance of skin lesions. The blood was either bright red in colour or very dark, giving the faeces a tarry appearance. Once blood came away from the intestines the faeces became soft, pultaceous, and had a somewhat offensive odour. The blood was clotted and in masses larger than a clenched fist and either mixed with mucous or shreds of mucosa, or in the form of red streaks. As the intestinal haemorrhages increased in severity the faeces became very fluid and were ejected with a great force from the rectum on to the walls of the stable, fittings, etc., which came to resemble in appearance a bay in a slaughter house.

Often the dysentery was not profuse. There may be very pronounced tenesmus followed by the evacuation of small clots of dark blood mucous or pure blood. This act was accompanied by much groaning and grinding of the teeth, while the animal stood with head depressed and back arched.

At this stage a heavy, sickly, disagreeable odour emanated from the body of the animal, while the faeces and the breath became very foul. In a few cases long shreds of intestinal mucosa forming a cast of the bowel were passed per rectum.

A very remarkable clinical feature was the delayed coagulation time of the blood. Unfortunately no chemical observations were made on this point but it was very noticeable that even small skin wounds, such as are made on the ear to obtain a drop of blood for the preparation of slides for routine blood examination, bled freely and showed so little tendency to clot that the animal stood in a small pool of

blood formed as the result of constant drippings from the ear. Similarly after the jugular venesection bleeding continued to take place both into the perivenous tissues and on to the exterior.

It is impossible to state definitely whether this condition was complicated by fever, as in most cases the patient had not yet recovered from its anaplasma reaction or it was still in a pyrexial condition due to the reaction. In this connection the history of Ayrshire heifer No. 27 may be referred to briefly. This animal was not vaccinated after she arrived at the quarantine station, as she was heavy in calf. She calved eight weeks after her arrival at the quarantine and during that time ran a steady temperature. Three weeks after calving her morning temperature began to rise, reaching 105° F. on the fifth day, after which it fluctuated between 104 and 105° F. for a further six days, when death occurred. On post-mortem this animal showed typical lesions of the disease. It may be added that certain other animals which had clinically finished their vaccination reaction showed a sharp rise in temperature when the haemorrhagic syndrome was, at its worst a few days before death. It seemed reasonable, therefore, to infer from these observations that the disease was accompanied by a mild febrile reaction.

Course.

In every untreated case the course of the disease progressed towards a fatal issue, but after the introduction of adrenalin as a curative the mortality was arrested. The course of the disease in treated and untreated cases was therefore quite different.

(a) In untreated cases the course of the disease varied in duration but always ended in death. The symptoms gradually became worse and the animal rapidly weakened as the result of continual haemorrhages. Anorexia was complete and recourse had to be made to the use of nutritious drenches to help to maintain the strength of the patient.

The intestinal symptoms were generally very pronounced and the animal appeared to bleed to death through the intestinal mucosa. Death was preceded by great prostration and weakness, though the animal never showed signs of coma. Respirations were very hurried, of a blowing nature and accompanied by groaning and moaning. The pulse at the rate of 100-80 per minute was very weak and at times imperceptible, while there was continual grinding of the

teeth. At the time of death the animal was so feeble that it could hardly struggle. The visible mucosae were generally extremely pallid and typical of a severe internal haemorrhage. In most cases during the last few days of life there was great oedema of the limbs, of the lower aspect of the trunk and neck so that the animal was very stiff and refused to rise. There was also a transudation of straw-coloured fluid through the apparent intact skin. This tended to dry and form scales or crusts over the oedematous areas.

The duration of the disease from the first appearance of the haemorrhages to death varied between four to eleven days, and the mortality, before the use of adrenalin, was 100 per cent.

(b) In treated cases. Whatever may be the time therapeutic action of adrenalin it cannot be denied but that rapid improvement and recovery followed its employment. Within fourteen days the visible mucosae became cleared of all haemorrhages and the epistaxis subsided in twenty-four to forty-eight hours. The dysentery was controlled and after a week blood was no longer observed in the faeces which thereupon recovered their soft consistence and odour.

The skin lesions were refractory and slow in clearing up. The haemorrhages, at first red in colour, turned purplish and finally the entire skin assumed a pale yellow colour. There was much epithelial desquamation and the hairs fell out in abundance, leaving extensive, bald, dry, corrugated areas covered with a dandruff-like scurf. Even with the aid of skin tonics and hair restoratives (*vide* treatment) it took three months or more for the hair to grow and cover the bald patches.

THE PATHOLOGY OF THE DISEASE.

(a) *Morbid Anatomy.*

The carcases were generally in fair condition and gave off a heavy disagreeable sudorific or uraemic odour. Rigor mortis appeared very rapidly and was very pronounced. Besides the presence of haemorrhages, the visible mucosae were very pale and bloodless. In many cases there was a bloody slimy nasal discharge, while the anal canal was dilated or plugged by a mass of dark blood-stained mucus. In bull No. 42 fresh red blood trickled from the anus.

In all cases except bull No. 42 cutaneous haemorrhages were found on every part of the body, especially noticeable on the hairless parts, e.g. perineum, sheath, etc. Here and there were alopectic areas where the hair had been shed and where the skin was nodular, corrugated, raw and covered by a bloody or serous exudation. In more advanced cases the skin was cracked, thickened and scurfy, and the lesions varied in size up to a foot square, but generally they were as large as the palm of the hand. They were noticed on the hind limbs, the popliteal area, thighs, sides of the neck and withers, side of trunk, etc.

Very remarkable subcutaneous tissues were present in every case. The subcutaneous areolar and intermuscular tissues were profusely infiltrated with oedematous, haemorrhagic oedematous, or purely haemorrhagic extravasations, which varied considerably both in size and severity and were often over one foot in extent and six inches in thickness. When these extravasations were purely haemorrhagic they resembled a large haematoma or the lesions of some anaerobic affections, but they were readily differentiated bacteriologically. When free from an admixture of blood they were gelatinous, soft and straw-coloured. These lesions were noticed over the flanks, along the abdomen, in the axillae, over the shoulders and neck and along the medial aspect of the thigh. These extravasations were the cause of the so-called oedematous swellings of the dependant parts noticed during life and were responsible for the serous transudations. Although they were best marked in the subcutaneous tissues, similar lesions could be traced in the connective tissue septa between the muscles. The musculature itself was very dark in colour, but did not show any gasey or necrotic lesions.

Sections through the skin haemorrhages showed that they had occurred into the hair follicles which consequently became swollen and formed the nodules seen on the skin during life. Subsequently the hairs fell out and the superficial layer of epithelium were cast off as result of the circulatory disturbances in the capillaries of the cutis vera and consequent degenerative changes in the layers of the dermis.

The Alimentary Canal.

The buccal mucosa was very pale but showed numerous diffuse submucous haemorrhages which varied in size. The large ones, measuring 3 cm. along their long axis, were found on the tongue and lips. The gums showed scattered ecchymoses, but the teeth appeared normal. Similarly

haemorrhagic spots were observed in the pharynx and oesophagus. There was always a pharyngitis, the mucosa being reddish purple in colour, swollen and covered with catarrhal material.

The first, second and third stomachs were normal, though in heifer No. 27 the submucosa of the omasal-abomasal orifice was swollen and severely infiltrated with a red gelatinous oedematous fluid.

The Abomasum.

The abomasum was gravely affected. The mucosa was either a deep rose pink in colour or a dirty slate grey, but it was always greatly swollen, soft, jelly-like, particularly the laminae which were greatly enlarged. The submucous tissues were infiltrated with a soft gelatinous fluid, the colour of red currant jelly. This infiltration was as a rule spread throughout the organ even, as in heifer No. 27, into the omasum; in a few cases it was localised, but the laminae were always affected. In heifer No. 27 and bull No. 42 the infiltration was so profuse that the wall of the abomasum was two to three times as thick as normally. In bull No. 42 the mucosa showed the presence of small ulcers which on an average measured .75 cm. in diameter. They had an angry appearance, with a black jagged border, and were very superficial in their distribution in the mucosa. The abomasum contents were always fluid and contained much blood (especially in bull No. 42).

The small intestines.

Ulceration was never noticed, but numerous punctiform haemorrhages were present through the gut. Capillary stasis in the form of rich red arborescences was more often noticed than genuine red haemorrhages. The mucosa was covered by a creamy pink catarrhal material. In the submucosa was a similar haemorrhagic infiltration as noticed in the abomasum. The bowel contents were fluid and mixed with bright blood. The lesions were least pronounced in the ilium,

The large intestines.

This part of the bowel was less gravely affected than the small intestines. Submucous haemorrhagic infiltration was only noticed in the caceum and coils of the colon. No ulceration was noticed and the colour of the mucous was a deep rose, indicating a moderate degree of stasis. The rugae of the rectum were liberally bespattered with punctiform haemorrhages. The bowel contents varied, often they were firm and contained much dark blood, or the blood was bright

red. Shreds of mucosa were often found in the lumen of the rectum, while long casts of the intestinal mucosa was recovered from the rectum of bull No. 20.

Mesenteric glands.

These were always swollen; juicy, pale in colour and exuded a pinkish creamy fluid.

Peritoneal cavity was either quite empty or contained thick bloodstained fluid, which might measure up to 1,000 c.c. Haemorrhages were also present. They were either rare and confined to either parietal or visceral peritoneum and present as petechiae, or they were very numerous, large, and varied in size from a pin-head up to a diffuse extravasation. In every case examined the face of the abomasum, omasum and adjacent surface of the diaphragm and rumen were occupied by a diffuse, soft, dark red suffusion, while a similar lesion was present on the opposing parietal serosa. In bull No. 42 the extravasation was as large as a man's head—a veritable haematoma which was undergoing fibrous organisation as indicated by the appearance of adhesions between the abomasum, diaphragm, omasum and rumen to the overlying parietes. The serosa of the intestines, diaphragm, mesentery and omentum were literally besprinkled with blood.

Spleen.

There were bright red haemorrhages varying in size from small petechiae to extravasations as large as the thumb nail and subcapsular in position and distribution. On section the pulp was dryish, somewhat swollen and reddish brown in colour. Generally the malpighian corpuscles were pale, large and prominent.

In heifer No. 27 there was marked tumor splenis, but the corpuscles were not unduly prominent, though the pulp was swollen and rich in blood. Very frequently there were soft pinkish fibrinous deposits on the surface of the capsule.

The liver.

Showed no constant lesions. In a few cases subcapsular haemorrhages were noticed, but they were very seldom larger than a pea.

Generally the organ was very friable, light brown in colour and contained little blood. In bull No. 20 the parenchyma showed bright red areas in many of the nodules,

some of which were completely filled. Microscopically these were due to extreme stasis of blood in the liver lobules. In many cases there were isolated areas of "nutmeg."

The bile was viscid, flakey, and the colour of golden syrup. The mucosa of the gall bladder was swollen and varied in colour from a rose-pink to a deep red as result of marked stasis of the vessels in the submucosa. No ulceration was recorded.

The urinary apparatus.

(a) The capsule stripped easily off the kidneys. On section the cortex was swollen, friable and generally pale in colour. Here and there were isolated dots like cortical haemorrhages and in many places the cortex was distinctly "nutmeg."

(b) There were generally small subserous and submucous haemorrhages in the bladder, or else the mucosa presented a rosy flush. The urine, when present, was normal, but was unfortunately not submitted for chemical examination.

The sexual organs.

(a) In heifer No. 27 the uterus, vagina and udder appeared normal. There were small subserous haemorrhages in the broad ligament.

(b) The genital organs in the male presented no lesions.

The respiratory system.

(a) There were numerous scattered miliary haemorrhages on the nasal mucosa and the presence of blood and mucous in the meati. In animals Nos. 20 and 27 the larynx and trachea were normal but otherwise these organs showed numerous submucous petechiae and the presence of slimy straw-coloured fluid in the passages. In bull No. 42 there were considerable haemorrhagic filtrations of the peritracheal tissues.

(b) The pleura, and contents of the pleural cavity, were normal in every case except in heifer No. 27, where there was a soft rounded blood clot as large as a man's head lying on the sternum in the middle mediastinum below, but between the main lobes of the two lungs. The clot was dark in colour and when moved was found to be saturated with dark fluid blood. In places it appeared to be undergoing early organisation, for it showed a fibrinous covering and fibrinous

trabeculae. It was largely covered by fat derived from the suprasternal adipose deposit. The aorta, venae cavae and pulmonary vessels were always quite normal.

(c) Subpleural and interstitial emphysema were common lung lesions. These organs were generally considerably inflated and appeared too large for the chest cavity, showing well marked costal impressions.

Except for the hypostasis and commencing red hepatisation which could always be traced to prolonged decubitus, the lungs showed no specific lesions beyond slight oedema and unusual bloodlessness.

Blood vascular system.

(a) The blood was fluid and lost its clotting powers. In the veins and cardiac ventricles it formed very soft soggy coagula. It appeared to be haemolysed and stained very deeply. No naked eye lesions could be found in any of the blood vessels.

(b) In bulls Nos. 20 and 42, and in heifer No. 27, there was blood in the pericardial cavity; in the case of No. 42, 200 c.c. was measured and in No. 27 about 100 c.c. In No. 20 the entire pericardial cavity was occupied and occluded by a soft dark red coagulum to which the pericardium were intimately connected by numerous delicate pinkish filaments which were apparently formed from organisation of the clot.

(c) Cardiac haemorrhages were quite typical. They varied in size from a pin-head to a diffuse extravasation and in places were 1cm. thick. They existed both under the endocardium and epicardium, giving the organ a reddish-black blotchy appearance. The cardiac fat was soft, gelatinous and pinkish in colour. In more mild cases the haemorrhages were chiefly found along the sulci coronarii and in every case there were scattered small pinkish deposits of fibrin on the epicardium. Petechiae were noticed on the atrio ventricular and semilunar valves.

The myocardium was swollen, moist, but firm. In colour it varied from a light mahogany brown to a watery pink. It showed linear or streaky red areas the size of a split pea or up to 1 cm. in length. In heifer No. 27 the heart muscle was somewhat friable and had a hyaline appearance.

Brain and nervous system.—Appeared normal.

(b) *Pathological changes in the blood during life.*

Unfortunately no physiological-chemical investigations were carried out on the blood during life so that no explanation can be offered for the phenomenon of the delayed coagulation time of the blood, which was such a characteristic feature of the disease. Further, as every case, except heifer No. 27, was either going through its Redwater-Anaplasmosis reaction or had not completely recovered from it, the blood picture was possibly obscured by the pathological changes caused by the anaplasma. In heifer No. 27, however, judging from stained blood films, the red and white blood elements showed no abnormal characters at the time the animal was suffering from the haemorrhages which ultimately caused its death. It is, of course, dangerous to dogmatise from one observation, but it may be suggested that there were no pathological changes in the blood during the disease. The observation on the blood of heifer No. 27 was of value in one respect, namely, that it showed the disease was not caused by visible protozoa or other blood parasites.

(c) *Pathological Histology.*

The haemorrhages in the subcutaneous, subserous and submucous tissues were found, histologically to be unaccompanied by any inflammatory process, but there was no evidence to show how such large amounts of blood escaped out of the blood vessels. As is well known, haemorrhages generally result from either *rhexis* or *diapedesis*, but careful examination of the blood vessels in the vicinity of the suggillations, both anatomically and histologically failed to reveal any gross breach in the solution of continuity of the vascular endothelium. It is possible, of course, that the injury to the endothelium was so slight as to escape detection even by the microscope.

Diapedesis is a passive process and may follow great dilatation of the vessels with stretching and thinning of the endothelium. This is especially likely to occur in places where there is no limiting pressure from the surrounding tissues, e.g. the nasal and intestinal mucosa, and the serosa of the pleura, peritoneum and pericardium.

As a result of the changes in the normal arrangement of the endothelial cells, perhaps aided by the action of some toxin thereon, the spaces between individual cells became

abnormally exaggerated and permitted leakages of corpuscular elements of blood from within the vessels to the outside perivascular tissues. Examination of the subcutaneous, subserous and interstitial muscular haemorrhages showed that while the red cells were always present in abundance, the number of white cells and the amount of fibrin formed was much below normal. There was no apparent cause, histologically, for this deficiency, but the scant amount of fibrin was quite consistent with the delayed coagulation power of the blood.

In the parenchymatous organs, spleen, hair follicles and lymphatic glands, the distribution of the peripheral vessels is such that they are subjected to considerable pressure by the cells of the organs and therefore any leakage of blood meets with considerable resistance. In none of the fore-mentioned organs, except the heart, were there any lesions which could be interpreted as resulting from diapedesis and in that organ the extravasations occurred in the subepicardial and subendocardial connective tissues. In structures other than the interstitial muscular and subcutaneous connective tissues, the subserous and submucous tissues, therefore, the lesions of the blood vascular system had not advanced beyond a very marked stasis.

Secondary changes, however, were noticed in the parenchymatous organs, e.g. degenerations and distortions resulting from the increased pressure, collapse of the tubular system in the kidneys, and advanced pressure changes affecting the myocardial fibres. In the liver every part of the lobules showed stasis, and in bovine No. 27 the sinusoids were so distended with blood that the liver cells were distorted into a variety of shapes. In the kidney the cortical capillaries were mainly affected and at times it seemed as if the glomeruli were bathed by pools of blood. The interstitial vessels also showed marked stasis and, when extreme, both glomeruli and tubules showed distortion and disintegration with marked desquamation, cloudy swelling, or/and fatty degeneration of the tubular epithelium.

The spleen was very full of blood, especially the sinusoids and capillaries of the pulp. The splenic corpuscles appeared normal, while there was marked stasis of the vessels in the capsule and trabeculae. Many of the endothelial cells of the pulp contained much pigment which reacted to the Prussian blue stain and thus appeared to be haemosiderin.

As regards the gastro-intestinal canal there was very considerable stasis in the vessels of the mucosa and villi, causing in most cases great distortion of the glandular elements. In the submucosa there appeared to be an escape of an oedematous fluid and many red corpuscles into the reticulum. The latter were responsible for the extensive submucous extravasations seen by the naked eye. It was not observed how blood escaped into the lumen of the gut from the turgid mucosa. Rupture of the surface vessels was not seen, neither was diapedesis.

Very likely the intestinal haemorrhages occurred by both processes, i.e. diapedesis from the overdilated surface capillaries and by direct injury to the swollen mucosa by the intestinal contents.

In the skin the vessels supplying both the hair follicles and cutis vera were acutely over-distended with blood. No extra-vascular diapedesis was noticed in this part of the body. There was considerable shedding of hairs in the vicinity of the large subcutaneous suggilations and transudation of blood or bloody oedema took place through the follicles. Both shedding of the hairs and the increased epithelial desquamation were the result of degenerative changes caused by the pressure of the suggilations and the increased vascularity of the part.

No data was available on the fact of the subcutaneous haemorrhages in animals that recovered under treatment. Most likely they were removed by the phagocytes in the usual manner, being treated as foreign bodies. The marked icteric pigmentation of skin would point to the liveration of much blood pigment during the process, but no attempt was made during the investigation to ascertain its characters, though possibly it was of the nature of haemosiderin.

Discussion on the pathology of the disease.

A study of the microscopic anatomy of the various organs and tissues failed to show the nature of the pathogenic agent, though it clearly indicated that, whatever its character, it set up specific changes in the peripheral vascular system, leading to hyperaemia or stasis in the solid viscera and to extensive haemorrhages in the more loosely built tissues.

Secondary degenerative changes were observed in the parenchymatous organs, while in one case there was marked deposition of blood pigment in the spleen. As there was no

abnormal destruction of the red blood cells in the other cases it is considered that, in this particular animal, the pigmentation was due to increased blood destruction as result of a long and severe reaction to anaplasmosis caused by the inoculation of Redwater-Anaplasmosis vaccine.

ETIOLOGY.

The cause of the disease remains obscure. Blood cultures made during life or from the heart blood at death, were invariably sterile. Streptococci and gram-negative lactose fermenters were recovered from various tissues of bull No. 42, bull No. 20 and heifer No. 27 (*see* Appendix No. 11).

The streptococcus was gram-positive, fermented inulin, lactose, saccharose, dextrose, salicin and raffinose. On blood agar it produced a slight haemolytic zone about the colonies, i.e. they were weak Beta types. In every way the organism resembled the typical bovine faecal streptococcus (Type B) described by Ayres and Mudge. It was non-pathogenic for cattle and rabbits.

The gram-positive lactose fermenter bore the characters of *B. coli communis*. The organism was slightly pathogenic for cattle as two intravenous inoculations of an emulsion of it killed two cattle in eighteen and twenty-one days respectively, without, however, the development of any purpuric symptoms.

Other bacteria isolated included *Staphylococci albus*, *aureus* and *citreus*; *B. proteus* and *B. Pyocyaneus*. None of them could be incupated as the casual pathogen.

Inoculation of blood from well marked clinical cases of the disease proved negative for equines, sheep, rabbits and other cattle. Exhaustive research also failed to reveal the presence of any protozoa or filtrable virus as the possible aetiological agent. The disease was not conveyed by actual contact.

Anaphylaxis was soon ruled out of consideration as the disease was observed in one non-vaccinated animal and in an animal which had only received its first inoculation. Fuller details are given in the Appendices Nos. 1, 2 and 3.

DIFFERENTIAL DIAGNOSIS AND DISCUSSION.

It is clear from the foregoing paragraph that no bacteriological cause can be held responsible for the disease, but reference to the available literature shows that there are certain well known pathological conditions which the quarantine disease resembles in many respects, viz.: (a) sweet

clover poisoning; (b) scurvy; (c) haemorrhagic diatheses, including bovine purpura haemorrhagica; (d) animal poisons as by members of the viperine group; (e) certain plant poisoning, e.g. *Gloriosa superba* (*Liliaceae*), certain of the African arrow poisons which act on the cardio-vascular system, e.g. *Acokanthera*, *Adenium*, *Strophanthus*, etc., and (f) mineral poisons which may have been administered maliciously. It must be remembered in considering the cause of this quarantine disease that, in the apparent lack of some definite microbiological agent, the casual factor or factors must be looked for in some condition to which both vaccinated and non-vaccinated animals were exposed.

The possibility of item (d) was soon expelled. Although viperine snakes are common on the Athi plains in the vicinity of the quarantine station, no poisonous members have ever been noticed in the proximity of the cattle. Snakes have been actually killed by the stable-boy in the cattle byres, but they were always identified as being harmless. In any case the pathology of viperine poisoning shows less extensive lesions than those generally recorded in the quarantine disease.

The exclusion of cardio-vascular poisons such as *Acokanthera*, *Strophanthus* and *Adenium* was more difficult, especially the first named. The other two poisons were soon dismissed as they are comparatively unknown to the natives of the Kenya highlands. On the other hand our knowledge of the pathology, symptomology, etc., of *Acokanthera* has steadily increased during the past three years so that the possibility of it being responsible for the mortality could be seriously considered.

As will be noticed in a separate paper, *Acokantherosis* is quite a common condition in Kenya and may occur in regular outbreaks simulating an infectious disease, e.g. Heartwater or Anthrax. It is also widely known that such tribes as the Wakamba, Masai, Lumbwa, Wanderobo, and Wa-Kikuyu are familiar with the preparation of an extract from the *Acokanthera* trees which is so highly toxic that it is only necessary to inoculate an infinitesimal amount through a scratch or other insignificant wound to cause death. The question of foul play by the use of this poison was considered, but was untenable on account of the striking differences in the pathology of

the two conditions. It may be mentioned that poisoning by *Acokanthera per os* requires relatively large doses and could not easily be done in large animals surreptitiously. In the following table the main differences in the pathology of *Acokantherosis* and the quarantine outbreak are set forth as follows, viz. :—

	ACOKANTHEROSIS	QUARANTINE DISEASE
Subcutaneous and skin Hæmorrhages.	Not present as such. There is generally marked engorgement of subcutaneous capillaries. Skin hæmorrhages absent.	Hæmorrhages are present varying in size from petechiæ to marked-extensive suggulations. Skin hæmorrhages are very characteristic.
Changes in Serosa.	Hæmorrhages are only present as petechiæ or ecchymoses. Very little or no free blood in the serous cavities.	Hæmorrhages vary in size from petechiæ to suggulations and may be 2-3 square feet in extent. Free blood may be found in one or more of the serous cavities and is generally very abundant.
Coagulation time of the blood.	No departure from the normal noticed.	Delayed coagulation is a noted feature of the disease.
Changes in Mucosæ.	Are those of an acute inflammation caused by an irritant poison.	No inflammatory changes present. Lesions are those specifically affecting the local vascular system.

In conclusion it is obvious that with careful clinical and pathological examination there should be no difficulty in differentiating *Acokantherosis* from the quarantine disease. Similarly poisoning by such plants as *Gloriosa virescens* and others may be distinguished by the nature of the pathology.

Mineral poisoning was excluded by chemical analyses of the viscera and of the water supply, for at one time "plumbism" was considered as highly possible.

Attention must now be paid to the three first named conditions, viz. : Sweet Clover poisoning and the hæmorrhagic diatheses chiefly bovine purpura hæmorrhagica and scurvy. With the exception of the latter, which has pathognomonic gingival lesions all the diseases have many features in common and they must now receive attention.

Sweet Clover Poisoning.

This disease has been described in several papers from North America by Schofield, Roderick and Schalk. It is said to cause serious loss every year west of the Alleghany Mountains. According to Schalk it has been observed in animals fed "on specimens of hay and silage that were moulded or at least possessed some degree of spoilage or damage"; and "it is further noted, however, that not all moulded, spoilt or damaged clover, hay and silage possess the disease producing qualities," and "it does not develop in cattle from eating good, clean, well preserved sweet clover, hay or silage." While Schofield was inclined to definitely blame "certain moulds" as the casual agent, Schalk qualifies the above quotations in his paper by adding that "unfortunately the disease factor in the forage cannot be detected by either laymen or scientists." It would appear from these authorities that sweet clover (*Melilotus alba*) in certain circumstances, as yet not clearly known, but generally as result of improper drying for hay or treatment in the silo, becomes toxic for cattle and causes well marked clinical and pathological symptoms.

Lucerne (*Medicago sativa*) is closely related botanically to sweet clover (*Melilotus alba*) and is rightly regarded as an excellent food for cattle. Recently, however, reports have appeared on the apparent toxicity of the plant under certain conditions. Thus, Dodds in Australia and Allen in India, have noticed an eczematous condition of the pigmented portions of the skin after exclusive feeding on lucerne, especially under the influence of sunshine, as the skin irritation disappears at night only to reappear next day. It is well known, moreover, that ingestion of certain foods, e.g. buck wheat (*Fagopyrum esculentum*), under irradiation or intense sunlight cause the condition known as "photo-sensitization," in which, besides the skin lesions of irritation, urticaria, etc., there are petechiae haemorrhages throughout the body and parenchymatous degeneration in various viscera. In severe reactions, experimentally, Shead, Caylor and Schlotthauer noticed "marked increases in the coagulability of the blood" and compared the condition to what is observed, pathologically, in Anaphylaxis, but generally "there was marked absence of pathological lesions." In the following table Sweet Clover poisoning and the quarantine disease are compared, both pathologically and as regards their symptomology.

	SWEET CLOVER POISONING	QUARANTINE DISEASE
Coagulation time of the blood.	Very delayed and may be so extreme that the clot phenomenon is absent.	Very slow but always sufficiently alarming in view of probability of fatal hæmorrhages.
Presence and nature of subcutaneous swelling.	Gait stiff and animal progressed with a limp. One or more subcutaneous tumor-like swellings over the fleshy parts of the body.	Very rarely noticed clinically. Oedema of limbs and belly was noticed in some cases, but never very prominently. Stiffness and difficulty in rising was only noticed in one case. (Bull No. 20).
Appetite.	Normal.	Complete anorexia.
Fever.	Subnormal and normal temperature.	Never subnormal. Apparently some fever. (Case No. 27).
Period between feeding and first appearance of loss of coagulation of the blood.	10-11 days but periods up to 28 days to 42 days occur.	The animal develops faatl symptoms after being fed on heavy lucerne ration for 70 days and over. However connection between feed and the disease was not established.
Site of hæmorrhage.	Greatest predilection for subcutaneous tissues and subserosæ, chiefly of pleural and peritoneal cavities.	In agreement except that pericardium was more affected than pleura, and the peritoneum always.
Nature of disease.	Always hæmorrhagic, never septicæmia.	Always hæmorrhagic never septicæmia.
Therapeutics.	Drug treatment is useless. Serum or fresh normal bovine defibrinated blood gives excellent results.	Blood or serum not used, but adrenalin is a specific and will save every early case.

It will thus be seen that pathologically it is remarkable that Adrenalin should have proved so successful in the quarantine outbreak and apparently not at all in Sweet Clover poisoning, for presumably Adrenalin was tried by Schalk in his drug treatment.

The lucerne fed to the quarantine was very carefully examined. It was always found to be in excellent condition and quite free from damage. Lucerne from the same cutting was fed as a supplementary ration in animals at Kabete Laboratory and was distributed to other farms in the country, without any ill reports.

Many farmers, however, both in South Africa and Kenya, do not regard lucerne as a first class feed if it is given in large quantities by itself. They regard it as a source of

gastro-intestinal trouble. Thus, in 1913, a farmer in the Cape Province writing to the Principal of the Grootfontein School of Agriculture, asks for information on the supposed irritating action of lucerne on the stomach causing gastritis and even death. The Principal replied that the lucerne could not possibly be implicated as the cause of the trouble and was inclined to blame some irritant plant baled in the lucerne.

The present position, therefore, is that the charge against lucerne as being connected in any way with the quarantine disease must be regarded for the present as not proved, even taking into consideration all the available circumstantial evidence.

Again, the differences in the pathology of the skin lesions completely differentiates the disease from those forms of photo-sensitization which occur in pigmented parts of the skin under a powerful sun in lucerne fed animals as described by Allen and Dodds.

The "haemorrhagic diatheses."—Finally there are two forms of haemorrhagic diatheses which may now be considered, namely scurvy and bovine purpura haemorrhages.

(1) Scurvy is very rare among the domesticated animals and is said to be found only in pigs and dogs. As is now universally known it is due to lack of Vitamin C in the food and can be readily prevented by feeding substances rich in so-called anti-scorbutic principle, e.g. fresh vegetables, greens and fruits. It is remarkable that herbivorous animals like cattle should be so refractory in showing symptoms of scurvy when fed for a year or more on a diet which the anti-scorbutic factor has been destroyed. Theiler, Green and Viljoen, in their research into avitaminosis as a possible cause of Lamziekte, made the following observations, which are of interest; namely that (a) "the vitamin content of green lucerne is high and relatively small quantities of it suffice to protect pigeons against polyneuritis"; (b) "it seems fairly certain that the exogenous vitamine requirements of cattle are extremely small"; (c) cattle fed up to periods of thirteen lunar months on synthetic rations of exceedingly low vitamin content, as judged by accepted criteria and pigeon analysis, failed to develop either Lamziekte or any other specific disease which could be diagnosed as an avitaminosis. The view is incidentally expressed that an avitaminosis in cattle is not likely to occur in practice unless manifested simply in an atropic form clinically indistinguishable from inanition."

Attempts were made at Kabete to set up scurvy in bovines by feeding liberal quantities of lucerne that had been autoclaved at 110° C. (1.41 atmospheres) for half-an-hour. No supplementary food of any kind was offered, but except for symptoms which resembled those of inanition, e.g. loss of condition, dry harsh erect coat, constant bellowing for food, etc., the animal certainly did not show the typical scorbutic pictures described in text books of human medicine.

All the above observations, therefore, clearly demonstrate the extreme difficulty of setting up experimental scurvy in bovines. Furthermore, although haemorrhages were observed in the quarantine animals, they could not be compared with pathogonomic lesions of scurvy, viz.: swollen, spungy, fungous condition of the gums, which bleed easily.

It is fairly conclusive, therefore, that the quarantine disease was neither scurvy nor any other deficiency disease, which the poverty of the diet in vitamins or fresh food principles might suggest.

(2) *Bovine Purpura Haemorrhagica*.—This is a very rare disease which has received comparatively scant attention. According to Hutyra and Marek it appears in animals without apparent cause, but it may be observed as a stable infection though transmission from animal to animal could not be established. Walker and Edmonds state that cattle and buffalo, presumably in India, are occasionally attacked with a form of purpura following mastitis or metritis. The chief contribution to this disease, however, has come from Egypt where Rabagliati has observed it in both Cyprus and Egyptian cattle undergoing hyperimmunisation against Rinderpest for the production of immune serum. As a rule the purpura appeared five to nine days after the fourth immunisation, but the period might be as long as the fifty-seventh day. Rabagliati has reviewed the literature of bovine purpura prior to 1925 and inclines to the theory of platelet deficiency as the cause of the disease.

It may be remarked in passing that bovine purpura, while comparatively common in Egypt, is very rare at Kabete, where it is exceptional to encounter cases of disease in animals undergoing hyper-immunisation for serum production.

In the following table the symptomology and pathology of the quarantine disease and the bovine purpura as described by Rabagliati are set forth for comparison, viz. :—

	BOVINE PURPURA HÆMORRHAGICA	QUARANTINE DISEASE
Fever.	Rare.	Undoubtly present but rare.
Nature of hæmorrhages.	Present on visible mucosæm eyelid and pharynx. Skin often becomes yellowish. Epistaxis frequent. Delayed clotting of blood from small wounds which may ooze for days.	Identical. Yellow colour of skin is only seen in animals which are recovering under treatment. Epistaxis is very frequent. Delayed clotting of blood is very noticeable.
Nature of fæces.	Soft and black as if mixed with tar. Large clots may be expelled and even pure blood at times.	Identical.
Subcutaneous œdematous swellings.	Rare. Found over sites of inoculation or along sides of body. Hard and show no tendency to suppurate or slough. Very slowly after recovery absorbed.	Rare. May effect body and limbs causing stiffness. They are firm and from them exudes a bloody serous fluid. Do not slough.
Hæmaturia.	Seen in 3 or 4 cases only. Brine becomes thick and dark as in Redwater.	Always absent.
Blood smears.	Advanced anæmia, <i>e.g.</i> , Polychromæasia, punctate basophilia, anisocytosis and poikilocytosis.	Blood changes always obscured by presence of anæmia and attendant anæmia, except in No. 27 where blood appeared normal.
Serous hæmorrhages.	Diffusely scattered, especially on the peritoneum, where, over the rumen, they were as large as soup plates.	Identical. Most marked in peritoneum and pericardium. Rare on pleura. The serous cavities contain blood.

	BOVINE PURPURA HÆMORRHAGICA	QUARANTINE DISEASE
Subcutaneous hæmorrhages	Vary in size up to 1/- piece or several inches. Hæmorrhages present in fat, general musculature and so numerous as to give the subcutaneous tissues a blotched appearance.	Are general in distribution and vary from scattered petechiæ to large hæmatoma like suffusions. They involve subcutaneous tissues, fat, intra-muscular connective tissues.
Heart.	Hæmorrhages on serous surfaces, in the myocardium and on all the valves.	The hæmorrhages may be so numerous as to entirely cover the serous surfaces.
Respiratory system.	Hæmorrhages in nose, pharynx, rarely in larynx and trachea and not always in the lungs. Often many on the pleura and may be very large in the lungs.	Common throughout the entire track. Lungs may show marked hypostasis.
Alimentary canal.	Hæmorrhages in mouth, pharynx, gullet and a few in the first, second and third stomachs. Numerous hæmorrhages in abdomen up to 1cm. in diameter. Not so numerous along the bowel but everywhere present. Blood stained fluid in abomasum and gut.	Identical. In the abomasum very small ulcers were recorded. They were never numerous.
Submucous changes.	Not recorded.	Very marked sero-bloody infiltrations into the gastrointestinal, sub-mucosa. Also seen, but more mildly, in the trachea and bronchi.
Nature of coagulation of the blood.	Very delayed.	Very delayed.

It will be observed that there are sufficiently marked differences between the quarantine disease and the purpura described by Rabagliati in Egypt, to regard them as separate diseases.

The haemorrhages are larger and more extensively distributed than in the Egyptian purpura, while other tinguishing features are the presence of ulcers in the abomasum, marked sub-mucous infiltration along the alimentary canal, the non-pultaceous nature of the spleen pulp, the presence of actual blood in large amounts in the serous cavities and the absence of haematuria in the Nairobi quarantine disease.

Concluding Remarks on the Nature of the Quarantine Disease.

That the quarantine disease is a new condition in animal pathology cannot now be denied.

Its etiology remains quite unknown, but pathologically the two outstanding lesions are : (a) capillary haemorrhages ; and (b) some biochemical change in the blood which causes interference with the normal clotting mechanism.

It is now generally accepted that the thrombocytes or blood platelets play a primary role in blood coagulation, for if they are greatly reduced in numbers or are excessively destroyed the blood shows very little tendency to clot.

Normally the numbers of thrombocytes in the blood are regulated by the reticulo-endothelial system and many investigators (Kaznelson and others) hold that hyperfunction of the spleen or the reticulo-endothelial system generally causes excessive destruction of the platelets and the appearance of purpura. It is a great pity that there is no clinical evidence on the behaviour of the platelets in the quarantine disease, but the remarkably slow coagulation time would strongly point to the probability that they are seriously involved.

Furthermore, there is an intimate relationship between the ordinary vascular endothelium and the reticulo-endothelium system. Developmentally their history is very similar, though in post-natal life they differ in structure and function. In certain parts of the body, however, the system performs the function of bounding vascular spaces, e.g. spleen pulp, without losing its characteristic phagocytic properties (Piney).

In several human infections there is a remarkable haemorrhagic endotheliosis, e.g. endocarditis lenta, in which the capillary endothelium is primarily involved, and Piney has recorded that a haemorrhagic diathesis may develop without any platelet deficiency.

The pathogenesis of the quarantine disease in its early stages remains very obscure, but theoretically it appears to be connected with hyperfunction of the reticulo-endothelial system leading to excessive platelet destruction and injury of the vascular endothelium.

Piney believes that if the interchangeability of the reticulo-endothelial and ordinary vascular-endothelium is true, one might expect that some morbid condition in which both are implicated must exist.

In animals undergoing immunisation against Redwater and Anaplasmosis the blood may show changes of profound anaemia and the worn out or broken down corpuscles would naturally be phagocyted by the reticulo-endothelial apparatus of the spleen. It is not difficult to understand that in susceptible animals the prolonged reaction to the inoculated protozoa would eventually upset the normal functions of the spleen, stimulate its phagocytic powers to hyper-activity, and thereby hastening the fate of all non-protozoan entities for which the reticulo-endothelial has specific phagocytic power. This theory collapses when applied to the cases of un-vaccinated animals.

Treatment.

Adrenalin hydrochloride is a specific. After it had been used on a few animals it was found that the mortality from the purpuric condition was finally checked. The dose given was β l of (Parke Davis) 1-1000 solution, given either subcutaneously or, in urgent cases, intrajugularly. As is well known, Adrenalin is rapidly eliminated from the blood stream and its action is very transient. It was found that the best results occurred when the drug was repeated on three or more occasions per diem, or indeed, more often if necessary in severe cases.

It is well known that Adrenalin is a vaso-constrictor and acts by raising the blood pressure from "peripheral stimulation of the vaso-constrictor mechanism of the systemic vessels, and of the accelerator mechanism of the heart." (Sollmann.)

Its action is most intense on the arterioles, especially of the vessels supplying the voluntary muscles and mucous membranes.

It was always thought that in the quarantine disease the haemorrhages, judging from the colour of the blood, occurred from the smaller arterioles and it now seems that the surmise was correct, since the Adrenalin obviously arrested the course of the disease by virtue of its specific physiological function on the lesser vessels of the arterial system.

No other drug treatment was tried, but, during convalescence, tonic powders containing preparations of iron, arsenic and nux vomica were given several times daily in the food.

Nutritious liquid food and as much green food as could be obtained were fed in order to tempt the animal's appetite and hasten the convalescence.

Treatment of the skin lesions proved to be very troublesome. Generally there were extensive bald areas excessively dirty, covered with exfoliated epithelial debris, over the neck, withers, shoulders, thighs, flanks, tail and perineum, etc.

The procedure was to wash the affected parts with a warm solution of 2 per cent caustic soda, followed by liberal application of lotion containing methylated spirits, olive oil and sodium salicylate.

It was, however, at least three months before the hairs regrew in profusion and the skin became clear of dandruff.

It is of interest to note that Schalk has found that after the inoculation of Adrenalin into normal subjects there is a thrombo-cytosis and similar, but very temporary results, were recorded following the use of Adrenalin in the condition known as Werthof's disease in man. Franck has reported that one mg. of supra-renin inoculated several times a day causes a persistent rise in the thrombocytic count, which, however, is very temporary and only lasts some three or four days or so.

In Werthof's disease splenectomy gives far better results than drug treatment.

Prophylaxis.

In view of the obscure etiology of the quarantine disease, it is manifestly impossible to make hard and fast recommendations on its prophylaxis. Pure-bred pedigree animals of all breeds require careful supervision in the tropics and before they are subjected to immunisation processes they

should be allowed to become thoroughly acclimatised in every way. Too much attention cannot be paid to the hygiene of animals both during the first months following their arrival in the country and during the sea voyage.

Better, more nutritious, and more varied food should be supplied than in the past, while every attempt should be made to obtain a fresh green food either grass or lucerne.

As regards immunisation against Redwater and Anaplasmosis, the following suggestions are made, viz. :—

(a) That the first vaccine should not be given immediately the animal arrives at the quarantine. Cases are on record where animals were vaccinated a day or two after their arrival in the country, while they were still "journey weary," foot-sore and out of condition.

(b) That the second vaccine should not be given until the animal has completely recovered from the first vaccine, i.e., until the blood stream is clear of protozoa and both the anaemia and temperature have passed off. There is no doubt that in the past some animals have received their second vaccine much too soon, while still reacting severely to the first vaccine. Such a procedure is a dangerous one and owing to the risk of fatal anaphylactic shock should be severely discountenanced.

SUMMARY.

(1) During the early months of 1929 a severe mortality occurred amongst imported pedigree bovines in the Nairobi Veterinary Quarantine.

(2) The disease had all the symptoms of an haemorrhagic diathesis and was characterised by haemorrhages into the skin, subcutaneous tissues, into one or more of the serious cavities and into the submucosae.

(3) A characteristic clinical feature of the disease was the delayed clotting time of the blood. Small skin wounds continued to bleed profusely for many days and it appeared as if the internal bleedings became uncontrollable and ultimately responsible for the death of the animal from exhaustion.

(4) The disease was noticed in animals which were subjected to the Redwater-Anaplasmosis vaccine. One case, however, was observed in an unvaccinated pregnant heifer which calved normally one month before she died from the disease.

(5) The etiology of the disease remains obscure. Whatever its nature the primary pathological lesions are delayed coagulation of the blood and injury to the vascular endothelium of the lesser vessels of the arterial system, as result of which haemorrhages occur into the tissues.

Bacteria, protozoa or a filter-passing virus can be definitely excluded as the casual agents. The disease cannot be conveyed by actual contact.

(6) Adrenalin administered freely in large doses proved to be a specific. Before its use the prognosis of the case was regarded as hopeless and the mortality was 100 per cent. Since it was first employed not an animal has died of the disease.

BIBLIOGRAPHY.

1. Special pathology and therapeutics of the domestic animals. (Hutyra and Marek. Vol. 1, page 289, 1926 edition.)
2. Purpura haemorrhagica in Cattle. (Wooldridge's Encyclopedia. Vol. 1, 1928.)
3. Purpura haemorrhagica. (D. S. Rabagliati, Journal of Comparative Pathology and Therapeutics, 1906. Vol. 19, page 113; 1925, vol. 38, Part 1, page 27.)
4. Damaged Sweet Clover. (F. W. Schofield, J.A.V.M.A. Feb., 1929, page 553.)
5. Pathology of Sweet Clover Disease. (L. M. Roderick, J.A.V.M.A. Feb., 1929, page 314.)
6. Sweet Clover Disease in Cattle. (A. F. Schalk, Veterinary Medicine, October, 1929, page 437.)
7. Recent Advances in Haematology. (Piney Churchill, 1928.)
8. Contribution to the study of deficiency disease with special reference to the Lamziekte problem in South Africa. (A. Theiler, H. Green and P. Viljoen, 3rd and 4th Reports of the Director of Veterinary Research, Pretoria, November, 1915.)
9. Diseases of Animals in Tropical Countries. (Edmonds and G. K. Walker, 2nd edition, 1929.)
10. Faecal and Buccal Streptococci in Bovines. (Ayres and Mudge, Journal of Infectious Diseases, 1923. Pages 33 and 155.)
11. A Manual of Pharmacology. (Sollmann, 3rd Edition.)
12. Principles of Pathologic Histology. (Mallory, Saunders and Co.)

APPENDIX I.

In this Appendix the protocols dealing with transmission experiments are set out. It will be observed that in no instance were positive results obtained.

A.—INOCULATION OF WHOLE BLOOD FROM SICK CASES.

Date	Origin of Blood	Animal Inoculated	Amount of Blood Used	Result
4-2-29	Heifer No. 27 obtained before death..	Ox 3024	5 c.c. Intravenously	.. ..
4-2-29	Bull No. 20 obtained before death ..	Ox 2312	ditto	.. ..
7-2-29	Heifer No. 68 obtained before death	Ox 2777	10 c.c. Intravenously	.. ..
23-3-29	Bull No. 41 obtained before death ..	Ox 2493	70 c.c. Intravenously	.. ..
6-2-29	Heifer No. 68 obtained before death..	Rabbit No. B	3 c.c. Subcutaneously	.. ..
6-2-29	Bull No. 37 obtained during life ..	Rabbit No. A	ditto	.. ..
7-2-29	Heifer No. 68 obtained during life ..	Sheep 3077 and 3042 ..	3 c.c. Subcutaneously into each animal	.. ..
7-2-29	As above	Equine 1240 ..	10 c.c. Intravenously	.. ..
12-2-29	Bull No. 42 bled during life..	Oxen 2429 and 2432 ..	25 c.c. Intravenously into each case	.. ..

B.—INOCULATION OF LAKED BLOOD PASSED PER BERKEFELD OR SEITZ FILTER.

Date	Origin of Blood	Animal Inoculated	Amount of Blood Used	Result
11-2-29	Bovine 66 bled during life ..	Ox 3274	10 c.c. Intravenously	No result
11-2-29	Bovine 68 bled during life ..	Ox 3238	ditto	"
11-2-29	Bovine 42 bled during life ..	Ox 3447	ditto	"
11-2-29	Pooled blood from 42, 66 and 68 during life	Ox 3254	ditto	"

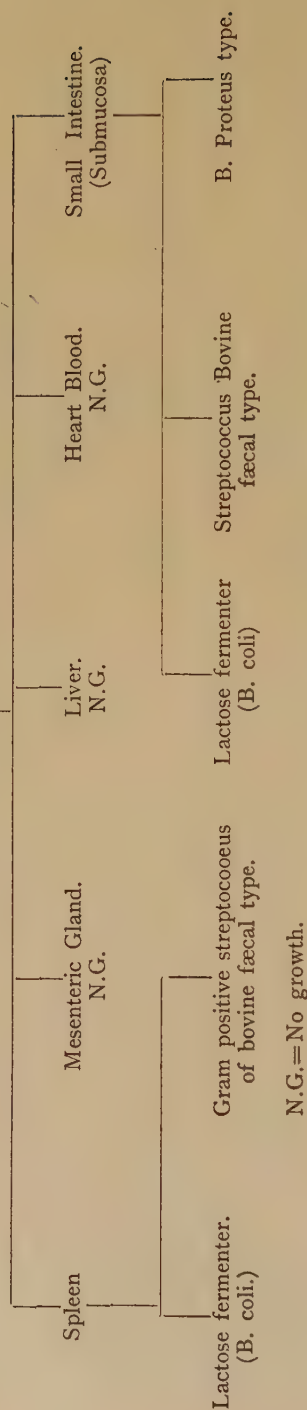
C.—CONTACT BETWEEN HEALTHY ANIMALS AND SICK BOVINES.

No. of Sick Bovine	Nos. of Incontacts	Duration of Contact	Result
Bull No. 42	Bovine 3264	From 24-3-29 to 1-5-29 <i>i.e.</i> , 38 days	No result.
Heifer No. 68	Bovines Nos. 3213 and 2602..	From 17-2-29 to 6-3-29 <i>i.e.</i> , 17 days	No result.

APPENDIX II.

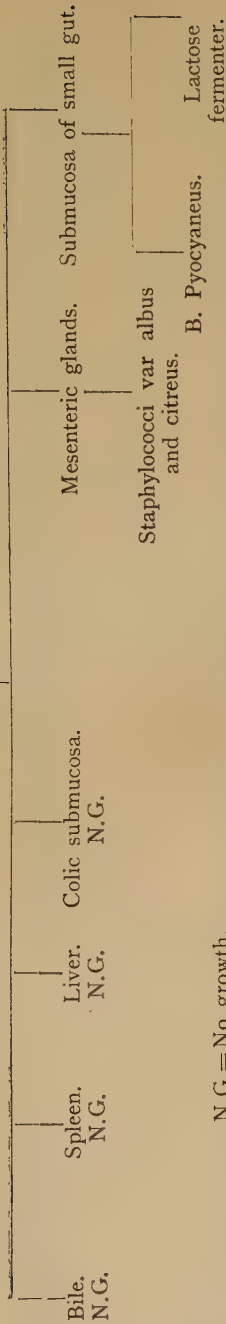
BACTERIOLOGICAL INVESTIGATION AND EXPERIMENTAL WORK WITH ISOLATED BACTERIA.

A.—From Tissues of Bull No. 20.



SUMMARY.—From spleen and submucosa of the small bowel on organism indistinguishable from *B. coli*, and a faecal streptococci were received. Cultures in this, as in every case, were incubated *aerobically and anaerobically*.

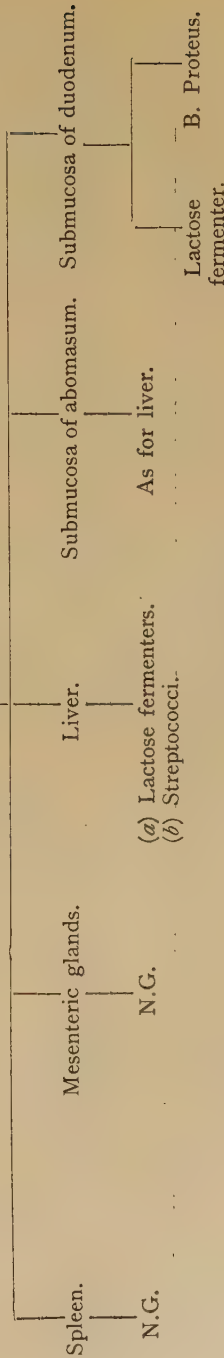
B.—From Tissues of Bull No. 32.



N.G. = No growth.

SUMMARY.—The viscera, other than the gut-associated glands, were free from bacterial invasion. Even in the gut the colic submucosa was sterile, and the growth from the duodenal and mesenteric glands was not profuse.

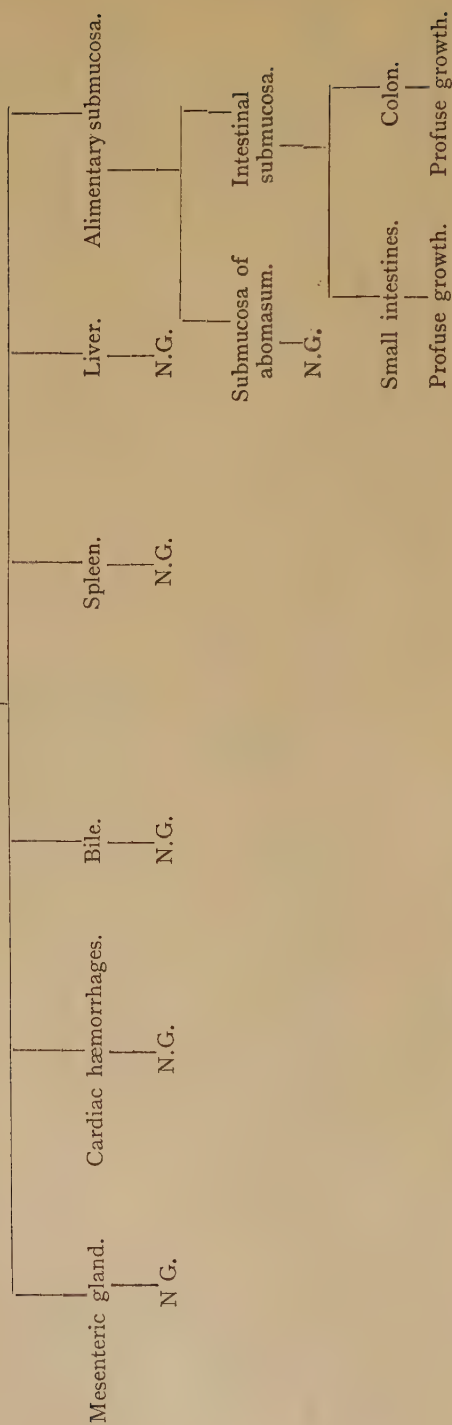
C.—From tissues of Heifer No. 27.



N.G. = No growth.

SUMMARY.—(a) Lactose fermenters from liver, gastric submucosa and duodenal submucosa.
(b) Streptococci from liver and gastric submucosa.
(c) Proteus type from duodenal submucosa.

D.—From tissues of Bull No. 42.



SUMMARY.—All the tissues examined outside the intestinal mucosa were sterile. In the duodenal and colic submucosa a growth was very profuse and showed a rich flora, including *B. Pyocyaneus*, lactose and non-lactose fermenters, streptococci, staphylococci and a few unidentified anaerobes,

Summary of Bacteriological Investigation.

It is obvious from the foregoing reports that no bacterial agent can be held responsible for the disease. The nature of the bacteriae that were found and their location, leave no doubt but they were secondary invaders and not connected with the etiology of the disease. However, in order to carry the investigation to a conclusion, cattle were inoculated with cultures of the *B. coli* type and streptococcus derived from the submucosa of the duodenum of bull No. 42 and the liver of heifer No. 27 respectively.

The streptococcus was not pathogenic for bovines and rabbits. It was soon proved to be the type of streptococcus faecalis bovis. The Lactose fermenter was not pathogenic for rabbits but killed cattle when large doses (50 c.c.) were given intravenously.

Autopsy of both these bovines (Nos. 3318 and 3324) showed patchy congestion of the alimentary mucosa with some oedemation infection of the submucosa. There was, however, marked absence of any haemorrhages into subcutaneous tissues or lesions of serosa. The connection of this organism, therefore, with the quarantine disease could not be established.

APPENDIX III.

In the following table the history of some cases in the Quarantine which developed purpuric lesions is briefly annotated.

No. and Sex	History in Quarantine	Reaction to Vaccine	History of Quarantine Disease	Remarks
Red Poll Bull No. 42.	Admitted on 20-11-28. 1st vaccine 13-12-28. 2nd vaccine 5-2-29.	Reacted severely to first vaccine. Animal died from typical hæmorrhagic Quarantine dis- ease 9 days after 2nd vaccine.	Disease ran a course 5 days before decease.	Typical case of the disease.
Ayrshire Bull No. 32.	Admitted on 20-11-28. 1st vaccine 17-12-28. Reinocu- lated with above on 11-1-29. vaccine 5-2-29.	After inoculation there was a good A. crentale reaction. Death occurred 9 days after 2nd vaccine.	Disease ran a course 6 days before death.	ditto.
Blue Albion Bull No. 11	Admitted on 20-11-28. 1st vaccine 20-11-28. 2nd vac- cine 25-1-29.	Very poor. No temperature re- corded over 103°F. Death or- curred 9 days after 2nd vaccine.	Disease ran a course 9 days before death.	ditto.
Heifer Ayrshire No. 27.	Admitted 20-11-28. Not vac- cinated as in calf. Calved on 5-1-29 a heifer calf.	Not vaccinated.	19 days after calving showed a sharp febrile reaction to 105°F. on the 5th day of illness. Died 4-2-29 after an illness of 11 days.	ditto.

APPENDIX III—(Contd.).

In the following table the history of some cases in the Quarantine which developed purpuric lesions is briefly annotated—(Contd.).

No. and Sex	History in Quarantine	Reaction to Vaccine	History of Quarantine Disease	Remarks
Shorthorn Bull No. 20.	Arrived on 20-11-28. 1st vaccine 27-11-28. Reinoculated with 1st vaccine 11-1-29.	None after 1st vaccine. After re-inoculated A. centrale immediately appeared in the blood, even then reaction was very mild and there were only two days when fever was noted.	10 days after reaction, epistaxis occurred and animal lingered 15 days before death.	Very typical.
Ayrshire Bull No. 31.	Admitted on 20-11-28. 1st vaccine 27-11-28. 2nd vaccine not given.	Reaction began on 28th day with Redwater parasites rare but on 3rd day of fever trypanblau was given. A. centrale was noticed on 2 days prior to death.	Hæmorrhages noted on 1-1-29 and death occurred on 8-1-29. These hæmorrhages were observed 35 days after vaccination.	Typical.
Red Poll Bull No. 41.	Admitted on 20-11-28. 1st vaccine 13-12-28. 2nd vaccine 23-5-29.	Very acute and prolonged. Reaction to A. centrale lasting 5 weeks; after which there was a high temperature for 21 days for no apparent reason.	Generalised hæmorrhages appeared on 22-3-29 and disappeared under treatment by 3-4-29. Long convalescence. At one time gravely ill.	Recovered under Adrenalin treatment altogether 30 c.c. 1-1000.
Shorthorn Bull No. 15.	Admitted on 20-11-28. 1st vaccine 20-11-28. 2nd vaccine 25-1-29.	Severe A. centrale reaction lasting for 21 days. Reaction to 2nd vaccine very mild.	Very mild. Ill for 31 days. Symptoms noticed 25 days after 2nd vaccine.	Recovered under Adrenalin treatment.

Remarks.

The following conclusions may be drawn from the above table, viz. :—

(a) That all the animals subsequently affected with the fatal quarantine disease arrived in the country on the same date, i.e. 20th November, 1928. This fact is being followed up in the hope that the history of these animals prior to their arrival in Kenya may afford some assistance in the elucidation of the etiology.

(b) That the disease appeared in vaccinated and non-vaccinated animals. Furthermore it appeared in certain animals which had only received the first vaccine (e.g. bull No. 31). It is quite obvious, therefore, that the disease cannot be in any way connected with Anaphylaxis.

(c) That the appearance of the disease cannot be referred to the inoculation of blood parasites in the vaccine, e.g. heifer No. 27, which was not vaccinated. Furthermore, the disease occurred in animals which reacted severely and mildly to the vaccine, e.g. Nos. 41, 15, 42, etc., in the first instance, and Nos. 20, 11, etc., in the second instance respectively.

APPENDIX IV.

In this Appendix the post-mortem records of cattle Nos. 31, 20, 11, 32, 27, 42 and 66 are set out in full.

IMPORTED PURE BRED BULL—QUARANTINE No. 31.

The post-mortem was carried out a few hours after death.

Alimentary Canal.

(a) There was nothing abnormal about the mouth, pharynx and first three stomachs. The mucosa of the abomasum was swollen, oedematous and shows a diffuse pinkness near the pyloric sphincter. No ulceration.

(b) The mucosa of the small intestine was the site of marked changes, especially in the jejunum and ileum. It was very soft and swollen due to infiltration with oedematous fluid; it was deeply haemorrhagic and pinkish red in colour; there was considerable stasis of the submucous vessels; a few superficial erosions were noticed, they were not deep enough to be called ulcers. The mesenteric glands were enlarged two or three times and very swollen. On section a watery, milky juice exuded, while the parenchyma was softish, swollen and pale.

- (c) The mucosa of the large intestine was pale or a slatey green colour. It was slightly swollen and moist.
- (d) The kidneys and liver were actively congested. Both organs showed commencing fatty changes in the glandular parenchyma.
- (e) The spleen was slightly swollen and showed mild tumor splenis. Sections showed the pulp to be pale in colour, moist and soft. Splenic corpuscles very prominent.
- (f) There were numerous red petechiae up to a pea in size, scattered over the omentum, peritoneum generally and on the peritoneal surface of the rumen.
- (g) The bladder was normal. No urine was present.

Thoracic Viscera.

- (a) The mucosa of larynx and trachea was moist, swollen and reddish in colour. There were numerous red petechiae scattered over the entire mucosa.
- (b) The lungs were oedematous and congested. No pneumonia and no pleurisy.
- (c) The heart : numerous large reddish purple petechiae on the epicardium, especially near the coronary grooves. The endocardium was generally normal, but showed a few small petechiae in a cluster near the apex of the left ventricle. Valves : normal.

The myocardium was very soft, moist and swollen. It was very pale, and had a parboiled fatty appearance.

Skin and Nervous System.

- (a) The brain itself appeared normal but there was considerable congestion of the meningeal vessels.
- (b) There were bare, rough, corrugated areas over the entire body, especially of scrotum, thighs, back, legs and neck. The lesions suggested a dry eczema.

Pathological Anatomical Diagnosis.—Acute haemorrhagic enteritis; generalised petechiae and stasis of sub-mucous and sub-serous vessels; fatty degeneration of heart muscle, kidneys and liver; congestion of meninges, spleen, lungs, liver and kidneys; dry eczema of skin.

POST-MORTEM ON BULL No. 20.

Died about 10 p.m. on 5th February. Autopsy 12.30 p.m.

External appearances.—Bloodstained mucous from anus. Rigor mortis present. Very heavy suderific odour from carcase. Condition excellent. Large raw bleeding eczematous lesions on external aspect of tibial region.

Abdominal cavity.—No tumor splenis. Soft. Contains much blood. Pulp is soft, dark, saturated with blood and corpuscles very large.

Liver.—Pale yellowish blue in colour. Extremely friable. Capsule bluish and shining. On section lobules are prominent, swollen and yellowish. Very often they appear as bright red dots, especially noticed in the region of the central vein. These dots appear to be haemorrhagic in origin and may completely or partially fill the lobules.

Gall bladder is full of viscid syrup like golden bile. The mucosa is swollen, moist and shows very marked submucous stasis of the vessels. The mucosa is deep red in colour.

Kidneys.—Capsule strips easily. Colour is pale brown. Sections show cortex to be swollen, moist and pale.

Bladder.—Normal. Urine appears healthy.

First to third stomachs.—Mucosa is normal. Contents normal. Abomasum. Mucosa is swollen, infiltrated with fluid—no blood—while the colour is slatey green.

Small bowel.—Mucosa is swollen, moist, covered with creamy exudate and shows marked stasis of submucous vessels giving rise to a deep pink colour of the mucosa.

Large bowel.—No apparent lesions. Faeces are dark in colour. No free blood seen but there are strings of false membrane, blood tinged, in the rectum.

Mesenteric Glands.—There are swollen and soft. On section they are pale, non-haemorrhagic, saturated with a watery milky fluid and very easily broken.

Thoracic Cavity.

No haemothorax. Pleural normal. No effusions.

Pericardium.—The visceral and parietal layers are connected by a dark red soft blood clot which lies between the two layers throughout the cavity. There are small rough isolated areas of fibrin deposit scattered over the epicardium, on the *A. pulmonalis* and *Aorta*. No signs of rupture of any vessels.

Epicardium.—*Vide supra*.

Endocardium.—Normal.

Myocardium.—The heart musculature is firm, moist, swollen and watery pink in colour.

Trachea and Larynx.—Normal.

Lungs.—No pneumonia. Collapse completely when thorax is opened.

(a) *Right Lung*.—Considerable hypostasis, leading in places to early red hepatization, of dependent parts of three lobes. No suppuration. Rest of lung is congested and oedematous.

(b) *Left Lung*.—No congestion. Oedematous and shows very mild and localised subpleural emphysema of the cardiac lobe.

Mouth Parts.—Quite normal.

Skin Lesions.

The two worst were on the tibial regions as described. They were irregular in shape, the size of the palm of the hand, and exuding blood.

The skin appeared thickened, was wrinkled and cracked. The hairs had entirely disappeared, leaving a red raw area. From the cracks and from the raw surface generally either blood or serum oozed and fell away in drops.

Pathological Anatomy.

Haemorrhagic moist eczema of the skin; haemopericardium; hypostasis of the right lung; fatty degeneration of liver with marked pigmentation of lobules or congestion; cloudy swelling of myocardium; catarrhal enteritis; congestion of gall bladder; oedema of lungs, stomach and mesenteric glands; subperitoneal haemorrhages.

BLUE ALBION BULL—QUARANTINE No. 11.

3/2/1929. Died 6 p.m.

4/2/1929. Post-mortem at 11.30 p.m.

Lymph Glands.—Prescapular and Precrural glands are swollen, moist and haemorrhagic. Some of them are saturated with blood tinged fluid.

Myocardium.—Very pale, greasy and soft. Advanced post-mortem changes. Epi and Endocardium are extensively post-mortem changed.

Spleen.—Very decomposed. Enlarged and swollen. No tumor. Pulp is soft, semi-fluid, full of blood, and dark in colour. Swollen.

Peritoneum.—A few haemorrhages near left *ext iliac* vein.

Liver.—Very decomposed. Soft. Light red and full of gas bubbles.

Kidneys.—Capsule strips easily. Decomposed. Pale and soft. Swollen.

Bladder.—Full of fermenting normal coloured urine. Mucosa is normal.

Stomach and Small Intestines.—Show extensive submucous haemorrhagic gelatinous infiltration. The mucosa is generally greenish in colour but in patches is bright pink, especially along jejunum and ileum. The faeces are dark and mixed with bright blood. The large intestine appears to be quite healthy.

As decomposition was very advanced, no attempt was made to obtain material for bacteriological investigation.

There were no obvious signs of bruising, injury or fracture.

Pathological Anatomy.—Congestion of spleen and all parenchymatous organs with fatty changes in the latter organs; submucous haemorrhagic infiltration of stomach and small intestines; lymphatic tissue generally congested and oedematous; post-mortem changes advanced.

BULL—QUARANTINE No. 32.

Died at 9.15 a.m. Rigor mortis present. Anus relaxed; brownish faecal discharge; conjunctiva much congested; no discharge from eyes and nose.

Large circular alopectic area behind umbilicus, where skin is thickened and shows haemorrhages into dermis.

Pericard.—Empty.

Thorax.—Empty.

Lungs.—Marked subpleural and interstitial empysema. Hypostatic congestion of lower parts of right lung. Parenchyma is pinkish, granular and moist. There exudes a pinkish fluid. Both lungs are very considerably inflated and appear too large for the thorax.

Heart.—Marked subepicardial haemorrhages near coronary vessels. These are black to deep red purple, and vary in size up to a split pea. Fat is soft and pink. Endocard is clear save for one subendocardial haemorrhage on right tricuspid valve.

Myocard is swollen, very friable, moist and reddish brown in colour. It has a swollen, opaque and fatty appearance.

Spleen.—Marked tumor. Slightly swollen. Some subcapsular haemorrhages. Soft. On section the pulp is swollen, soft, very dark and contains much blood. Corpuscles are not prominent.

Mesenteric Glands.—Show few changes. Slightly moist and swollen.

Liver.—Enlarged and swollen. Light brown in colour. Very friable. On section is putty-coloured, very soft and easily torn, contains much blood and in places is distinctly "nutmeg." Lobules are prominent, yellow-putty in colour, with dilated central veins.

Gall bladder is full of greenish golden bile. It shows subucous congestion.

Urinary bladder.—Full of normal coloured urine. Mucosa is pinkish.

Omentum.—Shows numerous red-purple petechiae.

Kidneys.—Capsule strips easily. Cortex is markedly mottled, reddish putty in colour and nutmeg in pattern. Extremely friable. Sections are swollen, greasy, moist and show numerous putty coloured areas of different sizes, up to two-shilling pieces, prominent and soft. These are areas of fatty degeneration. Vessels contain much blood. Medulla is congested.

Rectum.—Shows large haemorrhages on rugae and in depressions between folds. Submucosa is normal.

Caecum and Colon.—Show diffuse swollen and port wine red condition of mucosa. No ulcers. Submucosa is normal.

Abomasum.—Mucosa is slightly swollen and deep pink in colour. No ulcers. Submucosa is free from haemorrhages.

Small intestine.—The first and second parts are chiefly affected and *nearly always* in the neighbourhood of Peyer's patches. The mucosa is swollen, soft and gelatinous, due to infiltration of fluid and shows haemorrhages. These may be

pin point or arborescent in pattern and exist singly or diffusely giving rise to a uniformly congested appearance of the mucosa. The mesenteric venous radicles show active stasis. As mentioned, these haemorrhages are most noticeable in the vicinity of Pyer's patches, which appear enlarged and swollen. No ulcers. The mucous is covered by a pinkish catarrhal material.

Buccal Mucosa.—Normal.

Pharynx and Larynx.—Mucosae are swollen, deep purple in colour and moist.

Trachea.—Shows mucosa to be deep haemorrhagic, very moist and swollen. Haemorrhages are similar to those seen in small gut. No evident infiltration of submucosa.

Pathological Anatomy.—Fatty degeneration of all parenchymatous organs; haemorrhages on the epicard and endocard; pronounced emphysema; congestion of the mucosa of small and large intestine; oedema of mucosa of fourth stomach; haemorrhages under mucosa of larynx, pharynx and trachea; congestion of lungs and spleen.

BULL—QUARANTINE No. 42.

Very poor condition. Free blood issuing from anus. No skin lesions. Haemorrhages present on conjunctiva. Mucid nasal discharge. Rigor mortis only partial. Intermuscular connective tissue gelatinous and infiltrated with blood or serum.

Large, very numerous, purple subserous irregular shaped haemorrhages under parietal, peritoneum and serosa of spleen, diaphragm, omentum, etc. These haemorrhages may be as large as a one-shilling piece, but are very irregular in contour and in distribution.

Blood is very watery and shows little tendency to coagulate; it appears haemolysed.

Abdominal Cavity.

In the abdominal cavity there is free watery blood present and fibrinous adhesions connecting viscera to the floor, especially the abomasum to the sternum and aternal attachment of diaphragm where the haemorrhages are dense, diffuse and black, leaving no normal serosa at all.

Thorax.

Pericard.—Contains 200 c.c. watery blood fluid. Much injected.

Heart.—Diffused haemorrhages all over epicard, especially towards apex. It is reddish black in colour, swollen and moist.

The myocard is swollen, brown in colour, moist and opaque; it shows large haemorrhagic streaks or centres.

The endocard shows numerous scattered deep red haemorrhages in both cavities.

Pleura.—Normal. The pleural cavity contains normal amount of serous fluid.

Lungs.—Very pale but much inflated. No adhesions to pleura. Sections are pale, free from blood, slightly moist.

Liver.—Bluish brown in colour. Subcapsular haemorrhages of different sizes and softish. Slightly swollen. On section light brown in colour. Lobules prominent and appear fatty. The organ contains little blood. Sections are slightly swollen and appear to be bile stained.

Gall bladder.—Shows large subserous haemorrhages. Very full. Bile normal.

Kidneys.—Light brown in colour. Friable. Capsule strips easily. Cortex is swollen, pale brown, moist and very soft. Evidently fatty.

Bladder full of normal coloured urine. Both subserous and submucous haemorrhages are present.

Mesenteric glands.—Enlarged. On section very swollen. often show small haemorrhages, are friable and saturated with pale bloody fluid.

Mucous membrane of mouth, tongue, larynx, pharynx and trachea show numerous large red scattered submucous haemorrhages. There is much haemorrhagic infiltration of the peritracheal tissues.

Abomasum.—Mucosa is pale in colour. It shows numerous large red or dark black ulcers scattered diffusely throughout the mucosa. The ulcers are not very deep; they may be the diameter of a fifty-cent piece, scarlet in colour and show very faint superficial erosions of the mucosa. Many of the red lesions are pure submucous haemorrhages.

Rectum.—Shows small haemorrhages along the rugae. There are numerous scattered small pea-like submucous haemorrhages on the rest of the wall.

Colon.—Generally as for the rectum, but milder. The mucosa is slate green in colour.

Large intestine.—Generally scattered submucous haemorrhages over which the m.m. may be eroded. Generally m.m. is swollen and infiltrated. No false membrane. Contents contain much dark blood and are firmish.

Small intestine shows at least three lesions, viz. :—

(a) Diffuse red pin point or irregular sized pin head haemorrhages existing either singly or agglutinated into elongated clusters.

These appear to exist in the mucosa itself.

(b) Submucous fairly superficial haemorrhages, with mild erosions of superficial layers of mucosa; these are similar in character to (a). They are often covered by a dark black dot over the centre.

(c) Deep haemorrhages in the submucosa, which appear purplish when viewed from the submucous side and deep red purple when seen from peritoneal side. These are due to haemorrhagic infiltration of the submucosa.

In the stomach, small intestine and colon, etc., there is considerable haemorrhagic gelatinous infiltration of submucous tissues.

Contents of small bowel are a pinkish catarrhal exudate.

Pathological Anatomy.—Extensive haemorrhages under all serosa and mucosa; congestion and fatty degeneration of all parenchymatous organs; haemopericardium; haemoperitoneum; lymphoid tissue generally is enlarged, juicy and saturated with a dilute blood fluid; haemorrhages and oedematous infiltration into submucous tissues of the gastrointestinal tract.

HEIFER—QUARANTINE No. 27.

Calved on 5/1/1929. Sick for seven to eight days
Interim after death about ten minutes.

There are skin lesions on udder resembling a moist eczema. The history of these skin lesions is that the hairs fall out and there are all the appearances of a moist eczema. This is followed by cutaneous oozing of blood or serum. If the lesion recovers, the part becomes callous, dry, bald and softly wrinkled. If extensive a recovered lesion has a similar appearance to the dry folded skin so typical of the skin of a case of healed sarcoptic mange.

Abdominal Cavity.

Spleen.—Swollen and marked tumor. Numerous large and irregular shaped and sized subcapsular haemorrhages. Sections are dryish, firm, reddish-brown in colour, with prominent similarly coloured trabeculae. Corpuseles not prominent.

Liver.—A few very small subcapsular red haemorrhages. The organ is yellowish brown, very friable and slightly swollen. On section many lobules are diffusely yellow in colour with open central veins. Generally the liver sections are friable, swollen and greasy on section.

Bladder is normal and contains much coloured urine.

Peritoneum.—There are very numerous subserous extravasations which are scattered mainly over the abomasum, omasum, great omentum, along small gut and on the parietes near the pelvic inlet. These haemorrhages vary in size and shape and may be as large as the palm of the hand.

Rumen.—Normal.

Reticulum.—Normal.

Omasum.—At the omasal-abomasal orifice the submucous tissues are infiltrated with a red gelatinous fluid. Mucosa and serosa are normal.

Abomasum.—The mucosa was diffusely slaty green in colour. The laminae were very swollen, juicy and soft. On removal of the mucosa there was an abundant submucous infiltration of a watery consistence and the colour of red currant jelly. This material lies under the mucosa of the fundus, pylorus and extends under the mucosa of the laminal folds. Regarded from the serous face this haemorrhagic infiltration may be seen as diffuse purplish red irregular shaped blotches. They are most numerous and best seen about the greater curvature. Contents of the abomasum are normal.

Intestines.—There are no mucous lesions noticeable throughout the bowel. There is the same submucous infiltration but towards the ileum, the mucosa being distinctly pinkish and swollen. Elsewhere it was slaty green. The entire mucosa of the small intestine is covered by a creamy pink catarrhal exudate.

In the large bowel the faeces appear harder than normal, blacker than usual, but distinctly covered and intermingled with fresh bright red blood.

Mesenteric glands.—These are swollen and on section are very juicy, softish and often haemorrhagic.

Thoracic Cavity.

Pleural cavity.—Contained a huge soft blood clot as large as a man's head, round in shape, lying between the main lobes of both lungs. The clot was soft, dark, and if moved was found to contain much uncoagulated dark fluid blood. In places the clot appeared to be slightly organised, especially above the sternum and sternal attachment of the diaphragm. Here it was covered by much fat.

Both lungs collapsed entirely as soon as the chest was opened. They showed much subpleural emphysema, were slightly oedematous and congested. In the right lung were a few miliary abscesses about the size of a pea and full of creamy pus. Around these abscess zones the lung tissue was deeply congested. Careful examination failed to show any rupture of the Aorta or of any of the other great vessels in this cavity. The Aorta was free from arteriosclerotic or atheromatous changes.

Pericardial sack.—Contained about one litre of dark fluid blood in which were softish coagula. There were small isolated fibrinous areas on both parietal and visceral layers of the pericardium. There was no evidence of rupture of any of the coronary vessels or of the great venous or arterial trunks entering or leaving the heart. There were large irregular shaped purplish extravasations under the epicardium over the right auricular appendage and the sinus venosus, otherwise only a few pin head haemorrhages could be seen under the epicardium itself. The endocardium, valves and the cavities themselves appeared normal.

The myocardium was very pale yellowish brown in colour, somewhat friable and swollen and had a greasy parboiled appearance.

Trachea.—The mucosa was pale. No haemorrhages. There was a considerable quantity of jelly-like yellow fluid around the lower third of the cervical portion.

Larynx and Pharynx.—The mucosa was pale but normal.

Tongue, lips, etc.—No lesions, generally the buccal mucosa was remarkable for its pallor.

Brain.—Seemed normal. Meningeal vessels not distended.

Sexual Organs.—Appeared normal.

Pathological Anatomy.—Tumor splenis with pigmentation; moist haemorrhagic eczema; fatty degeneration of liver; submucous oedema and haemorrhages of abomasum; and small intestine with catarrhal exudation of the mucosa and presence of free blood in the bowel; haemothorax, haemopericardium.

RED-POLLED HEIFER—QUARANTINE No. 66.

Clinical history.—Admitted from quarantine on 7/5/1929.

External appearances.—Fair condition. Slimy vaginal discharge. Visible mucosae are pinkish in colour. Rigor mortis present but passing off. Abdomen not distended.

Peritoneal cavity.—Normal.

Mouth.—Normal.

Pharynx.—Reddish purple in colour. Tonsils very large. Glands swollen.

Oesophagus.—Normal.

Stomach.—Nearly empty. Mucosa is rose pink in colour; fourth stomach, the mucosa rose pink in colour, swollen and oedematous. Several small shallow erosions. Localised red submucosal petechiae.

Duodenum, Jejunum and Ileum.—The mucosa is moist, swollen and studded with numerous red haemorrhages which may be aggregated into distinct extravasations.

Caecum, Colon and Rectum.—Mucosa is swollen, moist and shows numerous submucous haemorrhages, least marked in the rectum.

Liver.—Swollen; colour normal; on section is full of blood, lobulation distended, light in centre and dark at the periphery. Some bile stasis.

Kidney, right and left.—Capsule is easily removed. Cortex is dark red brown in colour. On section it is swollen, moist and deep red in colour. Generally firm in consistence it is, in places, very friable. Numerous large haemorrhages are scattered throughout the cortex. Medulla is swollen and deeply congested.

Bladder.—Empty. Mucosa is thickened and deep rose pink in colour.

Thoracic cavity.—Contains no excess of fluid. Pleura is injected. Some recent fibrous deposit over ribs.

Larynx.—Epiglottis is deeply injected.

Trachae.—Mucosa is swollen and studded with petechiae.

Bronchus, right.—Injected.

Bronchus, left.—Deeply injected.

Lung, left and right.—Inflated and very doughy in appearance. Generally deep red in colour. On section contains much blood and oedematous fluid.

Pericardium.—Normal.

Epicardium.—Deep pink in colour; numerous petechiae over the atria.

Myocardium.—Swollen, soft and moist.

Blood.—Dark in colour; forms soft coagula but stains deeply.

Spleen.—Marked tumor. Very swollen. Pulp is dark, dry, swollen and soft. Trabeculae and corpuscles are not prominent.

Lymphatic glands.—Generally swollen and moist.

Muscular tissue.—Subcutaneous oedema is present throughout the body, especially in the mammary region. It forms yellowish, jelly-like infiltrations, up to the size of a soup plate.

Sexual system.—Pregnant. Uterus contains small bull foetus, apparently normal, about four months old.

Microscopic results.—Pathological anatomical diagnosis; acute subcutaneous oedema; stasis of blood in mucosa and submucosa of abomasum and intestines; tumor splenis of liver, lungs and kidneys; cardiac petechiae; tracheal petechiae; haemolysis of blood and delayed coagulation.

APPENDIX V.

According to the information supplied by Veterinary Officers E. Beaumont and Mackay, of the Nairobi district, a disease similar in its symptomology and pathology to that described in this paper has been diagnosed in both dogs and cattle in the township of Nairobi.

(a) In the dog the symptoms were profuse nasal and buccal haemorrhages with diarrhoea and, subsequently, dysentery. There were also very pronounced conjunctival petechiae. The house boy accidentally trapped the dog's tail in a door and the animal nearly bled to death from uncontrollable haemorrhages from a wound made by the bruise. The animal was a great Dane and belonged to a wealthy owner, so that it was very well looked after. It had had a severe attack of canine piroplasmosis some three months previously. The animal recovered after two intramuscular injections of Adrenalin (2 c.c.) Parke Davis 1-1,000 preparation.

(b) Two municipal work oxen died and were post-mortemed by Veterinary Officers Beaumont and Mackay. Both showed numerous diffuse subserous and submucous haemorrhages with free coagulation blood in the lumina of the intestines. Conjunctival haemorrhages were very marked.

Veterinary Officer Beaumont saw most of the autopsies at the quarantine and he readily recognised the same condition in these two beasts.

The cattle had been grazing on the Athi Plains near the Quarantine Station for some time prior to death.

The cause of the death could not be ascertained.

TRYPANOSOMIASIS.

EXPERIMENTAL TREATMENT.

By R. Daubney.

During the year the Assistant Chief Veterinary Research Officer has collaborated with members of the field staff in carrying out experimental treatment of trypanosome infections in cattle in various districts. Some experiments have been made with Antimosan, an antimony preparation, specially prepared for intravenous injection by the I.G. Farbenindustrie, and particular attention attaches to a comparison of the results obtained with this preparation and with antimony tartrate, which has been used in the bulk of the treatments. The progress of the animals has been controlled by frequent smear examination, and it is hoped that the records which will later be available will furnish an indication as to the value of treatment as a measure of control in this country.

HORSE SICKNESS.

PROPHYLACTIC VACCINATION EXPERIMENTS.

By S. H. Whitworth.

The disease, African Horse Sickness, has been extensively investigated by Sir Arnold Theiler in South Africa, and his researches on the disease have been published in the various reports of the Director of Veterinary Education and Research for the Union of South Africa.

As the result of Sir Arnold Theiler's investigations, it has been proved possible to protect horses and mules against fatal horse sickness infection in the majority of cases, by (1) paying particular attention to the stabling, and prevention of bites of blood-sucking insects, and (2) by means of artificial immunisation.

It is suspected that horse sickness is insect-borne, but, as yet, the particular insect concerned has not been definitely determined. As the result of observations made at Onderstepoort over a number of years during the horse sickness season, some species of *culicinae* is regarded with suspicion. Accordingly, if horses or mules be stabled in mosquito-proof stables, they are efficiently protected against infection. If such accommodation be not possible, it has also been proved that satisfactory results can be obtained by smoking the stable out and maintaining the smoke during the night. Where horses are to be used at night, deterrent skin dressing, e.g. paraffin, may be applied with good results. Such treatment has obvious disadvantages. Experiments carried out to determine the value of short interval dipping in specially prepared insect repellent fluids indicated the method to have some value, although not entirely satisfactory.

The movement of horses from horse sickness infected areas to higher altitudes where the disease is relatively rare, or absent, can be resorted to with advantage, but is not always possible. Moreover, horse sickness does occur even at the higher altitudes; in Kenya Colony, outbreaks of the infection have occurred at altitudes of 10,000 feet.

The above methods therefore in the control of horse sickness have only limited application, and are of special value in valuable horses, or where a small number of animals come under consideration.

Artificial immunisation of equines against horse sickness has received a great deal of attention, and as a result a method has been introduced by Sir Arnold Theiler, and which, taken

over a large number of animals, gives satisfactory results. The method consists in the simultaneous inoculation of a specially selected horse sickness virus and hyperimmune serum obtained from a hyperimmune animal, followed seventy-two hours later by a similar inoculation. This inoculation actually produces a horse sickness reaction, which in some cases is hardly noticeable; in others, definite and severe; and in a few cases is followed by mortality. The experience in South Africa is that in horses so treated a mortality of 5 per cent may occur, and in mules a mortality of 1 to 2 per cent from horse sickness produced by the inoculation. Occasional mortality results directly from the inoculation itself. Both the virus and the serum are injected intravenously, and since the amount of serum injected, viz. 400 c.c., is large, death may occur apparently from shock, especially if the serum be injected too quickly. Since there are many strains of horse sickness virus, horses immune to one or more strains may not be immune to another particular strain. Indeed, horses may react more than once to one particular strain. In the practice, however, the mortality amongst artificially immunised horses on exposure to infection is not great, and may be considered to be 5 to 10 per cent in the case of horses, and 2 to 3 per cent in the case of mules. Breakdowns in immunity on exposure with recovery also occur. Although this method of immunisation has proved fairly satisfactory, it must be considered to have certain disadvantages, and present certain difficulties in its application. These disadvantages may be indicated as follows :—

1. The horse sickness reaction may prove fatal, or may be so severe as to affect the constitution of the inoculated animal.

Horses which have reacted may not be able subsequently to withstand hard work.

2. Certain diseases other than horse sickness may be transmitted in the virus itself. These may be pernicious anaemia, biliary fever and trypanosomiasis. Special precautions can be taken to avoid transmitting these latter infections by using blood virus which has been kept sufficiently long for the parasites of biliary fever and trypanosomiasis to die. In the case of pernicious anaemia the blood may also be kept sufficiently long for this virus to die out, and since this may take a year, the blood can then be inoculated to horses known not to transmit pernicious anaemia. Old horse sickness virus sometimes does not produce horse sickness on inoculation to susceptible equines.

3. Cases of liver atrophy with fatal issue sometimes follow horse sickness immunisation. The relation of this condition to horse sickness immunisation is not known, but has been observed to follow the process both in South Africa and Kenya Colony.

4. The technique of the inoculation itself requires considerable skill to be applied with safety.

5. The care necessary in the production of serum with regard to its sterility, and the exclusion of sera haemolytic for the blood of other equines, entails much work, while the expense of serum production and the maintenance of virus for inoculation is considerable.

6. The inoculation of horse sickness virus may give rise to a horse sickness reaction, and so maintain the infection, since it is known that a recovered horse may harbour the virus in the blood up to a period of ninety days.

In any attempt, however, to produce immunity, it is very likely that the best results will be obtained if horses are subjected to an immunity test with material of some virulence. This question is discussed later.

In view of the satisfactory results which have been recorded in artificial immunisation against diseases such as distemper and rinderpest, by the use of treated tissue extracts, e.g. spleen, experiments were commenced at the Veterinary Research Laboratory early in 1929, and are still in progress, to determine whether a similar prophylactic vaccine could be prepared from treated tissues, e.g. spleen, of horses reacting to horse sickness. Such a method, if successful, might obviate some of the disadvantages of the virus-serum method indicated above, and it was with this object in view that the work was undertaken. The cost of equines for experimental work in Kenya Colony prevents any work on a large scale, and does not allow of any work being done with various modifications in the preparation of inoculation material, or extensive observations on the value of various material, e.g. spleen, liver, gland, kidney, blood, etc.

In the first place, the object of the experiments has been to determine the value, as an immunising agent, of treated spleen material from a case of horse sickness. As will be seen below, this point has been proved. Attempts were then made to obtain results which would be of practical value. At the same time, the observations made are of considerable interest

when compared with similar work carried out on other ultra-visible virus diseases, e.g. rinderpest and swine fever, in this Colony.

The spleen, collected as aseptically as possible either from a horse slaughtered during horse sickness reaction, or immediately after death of the animal from the disease, was passed through a Latapie pulper, weighed, mixed with varying amounts of saline solution, and then the mixture screened through muslin to remove the fibrous portions of the spleen.

In the original experiments, the amount of formalin added was in excess of that which was ultimately found necessary to destroy the virus in the spleen material. Moreover, in order to hasten this destructive action, the material was incubated at 38° C. for periods varying from four days to several weeks.

In the later experiments the material when prepared was immediately transferred to the ice-chest. It was found that although the period necessary for the inactivation of the material was longer, the material could more easily be kept sterile, and was probably of greater potency than material which had been incubated. The latter point is not yet definitely proved, however. As yet, the action of only two drugs on the horse sickness spleen material have been tried, viz. formalin and toluol.

It has been proved that toluol added to make a 3 per cent solution of the total bulk of spleen emulsion in saline, has no action on the virus over a long period. To date, material so prepared has proved virulent after a period of eight months.

Formalin, on the other hand, is very destructive to the virus, weak dilutions, e.g. 1/1,000 formalin, destroying the virus in the incubator in a few days. This period is prolonged when the material is kept in the ice-chest.

The following results have been obtained :—

Material containing 1/600 formalin and 1/800 formalin, and kept in the ice-chest, were still virulent after six days (*see* Horses 1308 and 1310), while material containing 1/1,000 formalin and kept in the ice-chest was still virulent after twelve days (*see* Horse 1302).

Materials similarly prepared, but kept in the incubator for four days prior to removal to the ice-chest, were completely inactivated.

As yet it has not been found possible to produce a vaccine containing living horse sickness virus which will protect, but will not kill, the animal inoculated, unless, of course, the animal has been previously inoculated with inactivated material. Therefore, to date, no material can be used as a vaccine for initial inoculation unless it has been proved *not* to produce a horse sickness reaction.

The time necessary for formalin to destroy horse sickness virus in the prepared material kept in the ice-chest depends on the concentration of formalin present, and further experiments are necessary to determine these periods accurately, since it is possible that the drug when present in high concentrations has a destructive action on the immunising agents contained in the vaccine. Experiments have been made with a view to determining this point, but the results are inconclusive, probably because the doses of vaccine inoculated were sufficient in all cases to prevent complete reactions when the immunity tests were made. Such experiments should be carried out on a large number of animals, using smaller doses of vaccine.

A point of interest is that all materials which have produced a horse sickness reaction in previously untreated horses, have produced fatal results (*see* Horses 1256, 1282, 1302, 1308 and 1310), with the exception of one horse (*see* Horse 1254), which gave a *very* severe reaction and recovered.

It should be noted, however, that in the case of formalin treated material the reaction was delayed according to the concentration of formalin added, for example :—

Horse 1302.—Inoculated with material twelve days' old, containing 1/1,000 of formalin. Reaction commenced on the fifth day, and the animal died on the eleventh day after inoculation.

Horse 1310.—Inoculated with material six days' old, containing 1/800 formalin. Reaction commenced on the sixth day, and the animal died on the ninth day after inoculation.

Horse 1308.—Inoculated with material six days' old, containing 1/600 formalin. Reaction commenced on the eleventh day, and the animal died on the thirteenth day after inoculation.

It would appear from these results that the period of delay in reaction was directly associated with the formalin concentration, but since a fatal issue resulted in each case there does not seem to have been any actual decreased virulence of the

virus. In toluol treated material, on the other hand, the first rise in temperature in each case commenced forty-eight hours after the inoculation of the material. (It should be noted that the period of incubation after the inoculation of horse sickness infected *blood* is usually forty-eight hours.) Again these reactions proved fatal.

Attempts are to be made to immunise horses by inoculation purely with inactivated spleen material followed by inoculation of material which produces a delayed reaction as indicated above. Apart from the value of the work in horse-sickness immunisation, the observations should prove of value in comparison with the work of a similar nature on rinderpest. The practically invariable susceptibility of the horse to fatal infection makes observations on any immunisation process of considerable value. It is recognised that the viruses of horse sickness may vary in virulence, although it is probable that there are actually very few strains, the breakdowns in immunity which have been recorded being actually due to the individual susceptibility of the animal itself. (It is known that in some diseases of the human being due to ultra-visible viruses, one attack confers lifelong immunity in all but a very few cases, those individuals who remain susceptible to a second or third attack being particularly susceptible and requiring more than one attack to confer complete immunity.)

The viruses of horse sickness which are used at Kabete have originated from cases both in South Africa and in Kenya Colony. One virus, which is referred to as the " O " virus, has been proved to produce a fatal issue in 100 per cent of inoculated susceptible horses, both in this Colony and in South Africa, where the virus originated.

The only mild virus used in experiments here is referred to as a first virus (*see* horse sickness virus 1259 and 18754). This virus originated in South Africa and does not kill all inoculated susceptible horses.

The virus referred to as second " O " virus (*see* horse sickness viruses 18755, 1264, 1280, 1287 and 1289) is merely a particular generation of " O " virus which produced a mortality of 100 per cent in inoculated horses.

The locally obtained horse sickness viruses are referred to as Virus 1255 and " Glitter " virus.

All other viruses referred to in the experiments are " O " viruses, some generations having been secured from South Africa and the remainder obtained by passage of the strain through local horses.

The following is a brief summary of the experiments. Reference should be made to the attached tabulated sheets for full details of the experiments :—

A.—TREATMENT OF SPLEEN WITH TOLUOL.

Origin of Spleen.—Horse 1253, inoculated 2-3-29 with horse sickness virus ex Onderstepoort. Horse sickness reaction commenced 5-3-29, and the horse was destroyed *in extremis* on 7-3-29. The material was prepared as described above, and toluol added in the proportion of 3 parts of toluol to 100 of the mixture (i.e. 3 per cent toluol). Placed in the incubator for eight days, and then stored in the ice-chest.

Inoculations.

(1) Horse 1254 inoculated 14-3-29 subcutaneously with 20 c.c. of the above treated tissue extract, i.e. material seven days' old.

Result.—Horse sickness temperature reactions commenced 17-3-29, and continued until 24-3-29, when dikkop symptoms appeared. This horse eventually recovered, although the reaction was very severe.

Immunity Tests were carried out on 2-4-29, 12-4-29, and 20-4-29, by inoculation of various known virulent viruses, but no reactions resulted.

(2) Horse 1256, inoculated 25-3-29, subcutaneously, with 20 c.c. of the above treated tissue extract, i.e. material eighteen days' old.

Result.—Horse sickness temperature reaction commenced on 28-3-29, and the horse died of typical acute horse sickness on 31-4-29.

(3) Mule 875, inoculated 2-5-29, subcutaneously, with 20 c.c. of the above treated tissue extract, i.e. material fifty-six days' old.

Result.—Horse sickness temperature reaction commenced 6-5-29 and the mule was destroyed on 11-5-29. (Spleen collected for preparation of more spleen material—see below.)

(4) Horse 1282 inoculated 24-10-29, subcutaneously, with 30 c.c. of the above material (i.e. material 231 days old).

Result.—Horse sickness temperature reaction commenced on 26-10-29, and the horse died of the disease on 1-11-29.

Conclusion.—Horse sickness spleen material prepared as above, and treated with toluol in the preparation of 3 parts of toluol to 100 parts of the mixture, was still virulent up to a period of 231 days, when it produced a fatal reaction.

In view of the results, this non-inactivated material and similarly prepared spleen material from other equines has been used in subsequent experiments to test vaccinated horses on their immunity.

As no more animals were available at this time from which to prepare vaccine, this toluol treated mixture was then treated with formalin, sufficient of the drug being added to make a 1 per cent solution. It was found that this treatment completely inactivated the spleen tissue, and experiments were then continued with the product. The resultant material, however, was too concentrated to pass through a needle, and had to be diluted with saline. Nevertheless the results obtained indicated the value of spleen extract, although the material kept for some months lost its potency, and did not protect Horse 1283 (*see* Tabulated Sheet) against a dose of horse sickness virus.

The results of these experiments can best be studied from the tabulated sheets. They include Horses Nos. 1271, 1276, and 1283.

B.—TREATMENT OF SPLEEN WITH FORMALIN.

In all, ten different spleens have been used in these experiments. In the first series, all material was incubated prior to being stored in the ice-chest. Moreover, it was not screened, and great difficulty was experienced in actually inoculating the material under the skin. The results, however, are included to give the complete series of experiments.

Spleen No. 1259. (Mild strain horse sickness virus.)

Origin of Spleen No. 1259.

Horse 1259 inoculated 5-3-29 with horse sickness virus ex Onderstepoort. Horse sickness reaction commenced 9-3-29, and the horse was destroyed *in extremis* on 14-3-29. The

material was prepared as described above, and commercial formalin added in the proportion of one part formalin to 100 parts of the mixture, i.e. 1 per cent formalin. This was then incubated at 37° C. for five days, and then stored in the ice-chest.

The following horses are included in this experiment : Nos. 1265, 1272 and 1281.

From the tabulated sheet it will be seen that none of the three reacted to immunity tests. They all eventually were reinoculated with various vaccines prepared from " O " virus spleens, and then tested on their immunity with " O " virus on several occasions, but no reactions followed any of these test inoculations.

Origin of Spleen No. 875.

Mule 875 inoculated 2-5-29 subcutaneously with 20 c.c. toluol treated spleen ex Horse 1253.

Horse sickness reaction commenced 6-5-29, and the mule was destroyed on 11-5-29. The temperature was marked but prolonged, and clinical symptoms were not severe. The mule would probably have recovered. The spleen was passed through the mincer, weighed and divided into five equal lots. To each lot was added saline as described above, and then formalin to each lot to make the following dilutions of formalin in the mixture : 1 in 100, 1 in 200, 1 in 400, 1 in 800, 1 in 1,000.

Each lot was put in the incubator at 37° for eight days, and the following inoculations made :—

(1) Horse 1273 inoculated 22-5-29 subcutaneously with 30 c.c. 1 in 400 formalised spleen; inoculated 31-5-29 subcutaneously with 30 c.c. 1 in 800 formalised spleen; inoculated 8-6-29 subcutaneously with 30 c.c. 1 in 1,000 formalised spleen.

Result.—No reactions.

Immunity Test.—22-6-29. Inoculated intravenously 5 c.c. H.S. virus 1256 of 30-3-29; inoculated intravenously 5 c.c. H.S. 875 of 10-5-29; inoculated intravenously 5 c.c. H.S. virus 450 of 25-3-29; inoculated subcutaneously 5 c.c. H.S. virus 1253 of 6-3-29; inoculated subcutaneously 5 c.c. H.S. virus 1241 of 1-3-29; inoculated subcutaneously 5 c.c. H.S. virus 1239 of 30-4-29.

Result.—Temperature reaction with recovery. Subsequent inoculations of virulent horse sickness blood produced no reactions.

(2) Horse 1277.—Inoculated 22-5-29 subcutaneously with 30 c.c. 1 in 100 formalised spleen; inoculated 30-5-29 subcutaneously with 30 c.c. 1 in 100 formalised spleen; inoculated 7-6-29 subcutaneously with 30 c.c. 1 in 400 formalised spleen; inoculated 17-6-29 subcutaneously with 30 c.c. 1 in 1,000 formalised spleen.

Result.—No reaction.

Immunity Tests.—15-7-29. Inoculated subcutaneously with 30 c.c. toluol treated spleen ex Horse 1253; age of material, 130 days.

Result.—Temperature reaction with recovery. No severe symptoms. Immunity tests carried out on 30-7-29, 7-8-29, and 20-8-29, were followed by no reactions.

(3) Horse 1278.—Inoculated 30-5-29 subcutaneously with 30 c.c. 1 in 1,000 formalised spleen; inoculated 23-6-29 subcutaneously with 30 c.c. 1 in 800 formalised spleen.

Result.—No reaction.

Immunity Test.—15-7-29. "O" virus intravenously 10 c.c. each of 1253 of 6-3-29, 450 of 23-3-29, subcutaneously 10 c.c., 1256 of 30-3-29.

Result.—Temperature reaction with recovery. Developed severe symptoms of dikkop. Subsequent immunity test carried out on 3-8-29 and 12-8-29 were followed by no reactions.

Spleen 1280 (Second "O" Virus).

Origin of Spleen 1280.—Horse 1280 inoculated 3-9-29 intravenously with 5 c.c. blood ex horse 1264 of 10-3-29. Reaction commenced on 6-9-29, and the horse was slaughtered 7-9-29, when the temperature was 104.4° F. The horse was then showing no other clinical symptoms of illness. The material was prepared as previously described. Horses Nos. 1287, 1289 and 1290 were inoculated with this material, which produced no reaction in either of the three cases. On tests, however, it will be seen from the tabulated sheets that Horses 1287 and

1289 reacted on immunity tests. These reactions were fairly severe, but were not accompanied by symptoms of dikkop, and the horses fed fairly well throughout, although they lost some condition. As a result of these observations, Horse 1290 was given two further inoculations with 1 in 1,000 formalised spleen 1280, and then tested on its immunity with toluol treated spleen ex Horse 1253, with a result that no reaction occurred either to this test or subsequent tests with virulent blood. As will be seen from later experiments, this spleen material (ex Horse 1280), collected early in the febrile reaction, does not appear to be so potent as material collected late in an otherwise fatal horse sickness case. Horse 1290 received in all six inoculations before immunity test was carried out, and then no reaction occurred.

Spleen 1283 ("O " Virus).

Origin of Spleen 1283.—Horse 1283 inoculated intravenously with " O " virus on 20-8-29. The horse reacted and died on the seventh day after inoculation of the virus. The spleen was collected immediately after death and prepared similarly to the previous spleen. Horses Nos. 1283, 1286, 1292 and 1295 were inoculated with this inactivated spleen material. Horses 1285, 1286, and 1295 were tested on immunity, firstly with toluol treated spleen ex Horse 1253, with the result that each gave a very mild temperature reaction with no other clinical symptoms whatever. Subsequent immunity tests with horse sickness blood gave negative results. Horse 1292, on the other hand, received horse sickness blood as first immunity test, with the result that a definite temperature reaction resulted, with only mild clinical symptoms, but no sign of dikkop. Although no definite conclusions can be made at present, experiments are being conducted to determine whether or not toluol treated material which is still virulent is nevertheless of value as an immunising agent. It would seem possible that virulent blood produces a more marked reaction in vaccinated horses than does toluol treated material, although both produced fatal results when inoculated to untreated susceptible equines. It might be mentioned here that kidneys and liver of Horse 1283 were also collected and treated with formalin in exactly the same manner as the spleen, and then inoculated to Horses 1291 and 1294, as per tabulated sheet.

It will be seen that neither horse survived immunity tests. This would indicate that kidney and liver are of no value, or possibly of little value, as immunising agents.

The reactions in both Horses 1291 and 1294 were typical and severe. The temperature in each case rose forty-eight hours after the inoculation of horse sickness blood, and the horses died on the fifth and sixth days after infection. These results agree with those obtained from rinderpest vaccination.

Spleen 1291 (" O " Virus).

Origin of Spleen 1291.—Horse 1291 inoculated intravenously with " O " virus 1283 on 14-10-29. Reaction commenced 16-10-29, and the horse died on 19-10-29. Spleen collected immediately after death and treated as indicated above.

Observations were made on this material to determine the effect of temperature on the potency of the vaccine, and with this object in view one horse, No. 1293, was inoculated with material kept in the incubator, and another horse, No. 1298, inoculated with material kept in the ice-chest. Neither horse reacted to the various immunity tests, the vaccine apparently being very potent. It should be noted that the spleen used (No. 1291) was from a horse which died after a very acute horse sickness reaction.

Spleen 1294 (" O " Virus).

Origin of Spleen 1294.—Horse 1294 inoculated intravenously with " O " virus 1283 on 14-10-29. Reaction commenced 16-10-29, and the horse died on 20-10-29 after a very acute reaction.

The observations made on this material were exactly similar to those made on the previous material (Spleen 1291), two horses, Nos. 1296 and 1297, being on the experiment. Neither horse reacted to the various immunity tests. Here again, the vaccine would appear to be very potent.

Further experiments on these lines were carried out, but to date no definite conclusion can be drawn, since all the materials used seem to be potent immunising agents, preventing reactions to immunity tests.

Spleen 1282 (" O " Virus).

Horse 1282 inoculated 24-10-29 with toluol treated spleen material ex Horse 1253 (material 231 days' old). Reaction commenced 26-10-29, and the horse died of acute horse sickness on 1-11-29. Spleen collected immediately after death and

prepared as before; except that to one part of minced spleen was added six parts of saline, and the material well screened before being returned to the ice-chest.

Several lots of the material were made with the addition of varying strengths of formalin, and individual horses inoculated with these preparations (*see* records of Horses 1299, 1300, 1301, 1303, 1304, 1305, 1306, 1313, 1314, 1315, and 1316).

Horses 1299, 1300 and 1305 were inoculated with material which had been incubated. Horse 1305 gave a doubtful reaction on immunity test. This is a yearling colt, and such animals frequently give an unexpected slight rise in temperature without any apparent cause. The remainder have shown no reaction to any immunity test.

Horses 1301, 1303, 1304, 1306, 1313, 1314, 1315, and 1316 were inoculated with material which had been kept at ice-box temperature. None showed reactions to any immunity test.

Horse 1302, inoculated with 1/1,000 formalised spleen ex Horse 1282, which material had been kept at ice-chest temperature for twelve days, reacted to horse sickness and died of the disease.

Here again no definite conclusions can as yet be drawn as to the comparative values of material prepared at different temperatures.

Spleen 1302 ("O" Virus).

Horse 1302, inoculated subcutaneously with 50 c.c. spleen 1/1,000 formalin ex Horse 1282. (This spleen material had been kept at ice-chest temperature for twelve days.) Temperature reaction commenced on the fifth day, and the horse died of acute horse sickness on the eighth day after inoculation.

Material prepared as previously, and all preparations kept at ice-chest temperature. The first inoculations were made after the prepared material had been kept at ice-chest temperature for six days. It will be seen from the results that 1/600 formalised material and 1/800 formalised, both transmitted horse sickness. (*See* Horses 1308 and 1310.) The remaining material proved inactivated, and the horses inoculated were subsequently tested on their immunity, with negative results. These horses include Nos. 1307, 1309, 1311 and 1312.

It will be seen from this series of experiments that horse sickness virus in spleen is not inactivated by weak dilutions of formalin except after a somewhat lengthy period.

Spleens 1308 and 1310 ("O" Viruses).

Horse 1308 inoculated 27-11-29 subcutaneously with 50 c.c. spleen 1/800 formalin ex Horse 1302. (This spleen material had been kept on the ice-chest six days prior to use.)

Temperature reaction commenced 3-12-29, and the horse died of acute horse sickness on 10-12-29.

Horse 1310 inoculated 27-11-29 subcutaneously with 50 c.c. spleen 1/600 formalin ex Horse 1302. (This material had been kept in the ice-chest for six days prior to use.)

Temperature reaction commenced 8-12-29, and the horse died of acute horse sickness 11-12-29.

Material prepared as previously and all preparations kept at ice-chest temperature. The horses inoculated with these materials and tested on their immunity include 1317, 1319 and 1320.

It will be seen that Horses 1319 and 1320 gave no reaction on immunity tests, whereas Horse 1317 gave a temperature reaction with practically no symptoms after first inoculation with virulent material. This animal is a small foal, and it is found that the absorption of the inoculated vaccine takes place very slowly in these small equines, the material remaining at the site of inoculation for some days before disappearing. The skin of a foal is firmly attached by dense fibrous tissues of the underlying structures, and this possibly accounts for the slow absorption of any semi-liquid injected material, with the result that immunity conferred by vaccine is rather delayed.

Spleen 1318.

Horse 1318 inoculated 23-12-29 subcutaneously with 30 c.c. toluol treated spleen ex Horse 1282. Temperature reaction commenced 26-12-29, and horse died of acute horse sickness on 30-12-29.

Spleen material from this horse has been prepared and observations on its potency are being made.

It should be noted that the Horse No. 1318 received material which had been used to test the immunity of several horses on experiment, viz. Nos. 1299, 1300, 1301, 1301, 1303, 1304, 1305, 1306, 1313, 1314, 1315, 1316, 1317, 1318, 1319 and 1320.

In addition to the above experiments, a number of horses are now being immunised with material prepared from various spleens. The immunity tests are not yet completed, but the results to date can be seen on reference to the tabulated sheets. These horses include Nos. 1321, 1322, 1323, 1324, 1325, 1326, 1327, 1328, 1329, 1330, 1331, 1332, 1333, 1334, 1335, 1336, 1337 and 1338.

GENERAL SUMMARY AND CONCLUSIONS.

The above experiments are not meant to indicate a definite and fixed method of immunising horses against horse sickness infection by means of spleen material (vaccine). The number of horses on the experiments are too few to warrant such a conclusion, but taken together they clearly indicate that such treated spleen material has immunising properties which can be of practical value, and which, with certain modifications and technique of preparation, etc., may eventually give rise to a simple and cheap method of immunisation.

The immunity tests to which treated horses have been submitted have been severe and all control animals, i.e. untreated horses which have been inoculated with the immunity test materials, have died after acute reactions.

As the method of infection in nature is unknown, it is not possible to speculate as to the severity of exposure to immunity tests, as compared with inoculation immunity tests. It is possible that, as has been proved in the case of rinderpest, exposure tests are less severe than inoculation tests with virulent material. If such were the case, the value of the method would be increased. In any case, it is anticipated that even though the inoculation process may not actually produce sufficient immunity to prevent natural infection on exposure it would produce sufficient immunity for some period to prevent a fatal issue. This period may depend on the method and preparation of material, and possibly the dose injected, but further experiments are necessary to effect these improvements, if possible.

Judging from the immunity produced by artificial means in other diseases, e.g. rinderpest, it is very probable that the strongest immunity is produced by a method which actually produces a reaction followed by a recovery. In the majority of such cases the immunity would no doubt prove life-long.

Work in this direction lies along the lines of balancing the action of inactivated material to produce sufficient immunity to prevent a fatal issue on inoculation of active horse sickness material. This latter product will possibly prove the more important, and comparative observations made on rinderpest spleen vaccination will probably prove of value. On the other hand, the observations which are being made on horse sickness virus will make useful comparison with other fixable virus diseases.

At the request of various settlers, a certain number of experimental inoculations are being made in the field, and careful record will be made of any observations noted. The material used for inoculations is completely inactivated spleen material, and the horses so inoculated will be exposed to such infection as has been experienced on the farms from time to time.

The Laboratory would like to take this opportunity of thanking horse owners for their kindly assistance in this work, and especially those who have provided horses for experimental inoculations—Mrs. Reynard, Major Furse, Captain F. O'B. Wilson, Major Joyce, Major Ridley, Captain Creery, Messrs. W. B. Thompson, H. M. Dempster, and E. G. G. Wilmot.

Lab. No. of equine on experiment	Type and origin of equine	Material inoculated	Treatment of tissue	Age of material at time of inoculation	Date of inoculation	Dose and method	Result	IMMUNITY TEST		Remarks
								Date	Material and method	
1265	2-year old country bred Somali colt born at Molo	Spleen ex H 1259	Formalin	Days 9 19 29	23-3-29	Subcutaneously 20 c.c.	No reaction	20-4-29	1st virus 10 c.c. ex H 1259 of 13-3-29	No symptoms throughout.
					2-4-29	30 c.c.	"	2-5-29	1st virus 10 c.c. intravenously No. 18754 and 10 c.c. subcutaneously ex H 1259 of 14-3-29.	
					12-4-29	30 c.c.	"			
1272	2-year old Arab-Somali gelding ex Molo.	"	"	35 43 51	18-4-29	30 c.c.	"	15-5-29	1st virus intravenously 10 c.c. each of No. 18754 and 1259 + subcutaneously 10 c.c. 1259 (14-3-29).	ditto.
					26-4-29	40 c.c.	"			
					4-5-29	80 c.c.	"			
1281	2-year old thoroughbred filly ex Reynard, Naivasha.	"	"	128 135 140 146 152	21-7-29	30 c.c.	"	20-8-29	1st virus intravenously 10 c.c. ex H 1259 (13-3-29).	ditto.
					27-7-29	30 c.c.	"			
					1-8-29	30 c.c.	"			
					7-8-29	30 c.c.	"			
					13-8-29	30 c.c.	"			
1273	Aged Somali gelding ex Naivasha.	Spleen ex M 875	Formalin (1-400)	11 20 28	22-5-29	30 c.c.	No reaction	22-6-29	"O" virus intravenously 5 c.c. each of 1256 (30-3-29), 875 (10-5-29), 450 (25-3-29), Subcut. 5 c.c. each of 1253 (6-3-29), 1241 (1-3-29), and 1239 (30-5-29).	Reacted and re-covered
					31-5-29	30 c.c.	"	22-7-29	1st virus intravenously 10 c.c. each of No. 18754 and 1259 (13-3-29) and subcutaneously 10 c.c. 1259 (14-3-29).	No reaction
					8-6-29	30 c.c.	"	30-7-29	2nd virus intravenously 5 c.c. No. 18755 (11-12-29) + 10 c.c. 1261 (10-3-29).	"
							"	7-8-29	Virus ex West Camp Understeepoor. Subcutaneously 20 c.c.	"

Temp. reaction, max. 104.4°F. Dull for several days. No dikop. This temperature reaction was quite severe, although this horse ran a temp. and was sick for some reason before being tested on its immunity. The horse is almost blind and objective symptoms were difficult to observe.

1277	2-year old Arab-Somali filly ex Gilgil	Spleen ex 1-100 " "	Formalin M 875 (1-400) (1-1000)	11 19 27 37	Subcutaneously 22-5-29 30-5-29 7-6-29 17-6-29	30 c.c. 30 c.c. 30 c.c. 30 c.c.	No reaction " " "	15-7-29 30-7-29 7-8-29 20-8-29	"O" virus vaccine subcutaneously 30 c.c. ex H 1253 Toluol 130 days. "O" virus intravenously 10 c.c. each of 1253 (6-3-29), 450 (23-3-29), subcutaneously 10 c.c. each of 1256 (30-3-29), 1273 (29-3-29). 2nd virus intravenously 10 c.c. 1264 (10-3-29). 1st virus intravenously 10 c.c. 1259 (13-3-29).	Reacted and re-covered No reaction " "	Temp. reaction 105.4°F. No dikkop. This reaction was not severe as regards symptoms. It was less severe than in the cases of
1278	Aged Somali mare ex Eldoret.	" " "	(1-1000) (1-800) "	30 44 53	30-5-29 13-6-29 22-6-29	30 c.c. 30 c.c. 30 c.c.	" " "	15-7-29 3-8-29 12-8-29	"O" virus intravenously 10 c.c. each of 1253 (6-3-29), 450 (23-3-29), subcutaneously 10 c.c. 1256 of 30-3-29. 2nd virus intravenously 10 c.c. 1264 (10-3-29). 1st virus intravenously 10 c.c. 1259 (13-3-29).	Reacted and re-covered No reaction "	Temperature reaction, 103.2°F. Developed severe dikkop.
1271	2-year old Arab-Somali gelding, born and from Molo.	Spleen ex H 1253 " "	Toluol + Formalin " "	69* 15† 81* 28† 89* 35†	15-5-29 27-5-29 4-6-29	30 c.c. 30 c.c. 30 c.c.	" " "	11-6-29 24-7-29 1-8-29 9-8-29 17-8-29 13-11-29	"O" virus intravenously 10 c.c. ex H 1253 of 30-3-29. "O" virus vaccine subcutaneously 30 c.c. spleen ex H 1253 Toluol 139 days. "O" virus intravenously 5 c.c. each of H 1273 (27-6-29), 1277 (20-7-29), 1278 (20-7-29) + subcutan. 5 c.c. each of 1273 (29-6-29), 1277 (22-7-29), 1278 (22-7-29). 2nd virus intravenously ex H 1264 of 10-3-29. 1st virus intravenously 10 c.c. ex H 1259 13-3-29. "O" virus intravenously 5 c.c. blood Onderstepoort 19677.	" " " " " " "	Appeared slightly dull on 18-6-29 and 19-6-29 but no temperature reaction. NOTE.—"O" virus vaccine is spleen ex H 1253 prepared with Toluol and kept for 139 days. It produced a Horse-sickness reaction in H 1277 (using material out of the same bottle), H.S. virus 1264 of 10-3-29 was inoculated to a horse (1280) on Sept. 2nd 1929 (last week) and produced a typical reaction. The horse 1280 was destroyed in extremis for collection of material.

* Toluol + Formalin

Lab. No. of equine experiment	Type and origin of equine	Material inoculated	Treatment of tissue	Age of material at time of inoculation	Date of inoculation	Dose and method	Result	IMMUNITY TEST		Remarks
								Date	Material and method	
1287	2-year old cross-bred Arab-Somali gelding ex Gilgil	Spleen ex H 1280	Formalin (1-100)	8	14-9-29	Subcutaneously 30 c.c.	No reaction	24-10-29	2nd virus intravenously blood H 1280 6-9-29.	Reaction commenced 48 hours after injection of virus. Fairly severe but appetite not impaired. No dikkop.
					21-9-29	30 c.c.	"	8-11-29	" O " virus intravenously blood H 1283 26-8-29.	"
					28-9-29	30 c.c.	"	22-11-29	" O " virus intravenously 10 c.c. Onderstepoort 19677.	"
					5-10-29	30 c.c.	"			"
					22-10-29	60 c.c.	"			"
1289	3-year old cross-bred Arab-Somali gelding ex Gilgil.	"	(1-100)	7	13-9-29	30 c.c.	"	14-10-29	2nd virus intravenously blood H 1280 6-9-29.	Temperature reaction commenced 48 hours after injection of virus Appetite not impaired No dikkop. Reaction not severe. . .
					21-9-29	30 c.c.	"	2-11-29	" O " virus intravenously Onderstepoort 19677.	"
					28-9-29	30 c.c.	"	8-11-29	" O " virus intravenously blood H 1283 26-8-29.	"
					5-10-29	30 c.c.	"	22-11-29	" O " virus intravenously blood H 1302 20-11-29.	"
1290	2-year old cross-bred Arab-Somali filly ex Gilgil.	Spleen ex H 1280	(1-100)	17	23-9-29	30 c.c.	"	18-11-29	" O " virus subcutaneously 40 c.c. spleen H 1253. Toluol 3%.	No symptoms throughout. (Compare inoculations of this horse with those of Nos. 1287 and 1289).
					30-9-29	30 c.c.	"	29-11-29	2nd virus intravenously blood H 1280 6-9-29.	"
					7-10-29	30 c.c.	"	9-12-29	" O " virus intravenously blood H 1283 26-8-29.	"
					14-10-29	30 c.c.	"	19-12-29	" O " virus intravenously blood H 1302 20-11-29.	"
					22-10-29	60 c.c.	"	28-12-29	2nd virus intravenously blood H 1280 6-9-29.	"
					2-11-29	60 c.c.	"			"
					9-11-29	60 c.c.	"			"

1285	2-year old cross-bred Arab-Somali gelding ex Gilgil.	Spleen ex H 1283	Formalin (1-400)	35	1-10-29	Subcutaneously 30 c.c.	No reaction	9-10-29	"O" virus subcutaneously spleen H 1253, Toluol 3%.	Temp. reaction com'g. 9th day after inoc. No reaction	Reaction very slight with no other symptoms.
1286	4-year old cross-bred Arab-Somali gelding ex Gilgil.	Spleen ex H 1283	(1-100)	8	4-9-29	30 c.c.	No reaction	5-10-29	"O" virus subcutaneously spleen 1253 Toluol 3%.	No reaction	No symptoms throughout.
		"	(1-1000)	16	12-9-29	30 c.c.	"	14-10-29	"O" virus intravenously blood 1283 26-8-29.	"	"
		"	(1-400)	24	20-9-29	30 c.c.	"	26-10-29	"O" virus intravenously Onderstepoort 19677.	"	"
		"	"	31	27-9-29	30 c.c.	"	8-11-29	"Glitter" virus subcutaneously 10 c.c.	"	"
								22-11-29	2nd virus intravenously blood H 1280 6-9-29.	"	"
1292	3-year old cross-bred Arab-Somali filly ex Gilgil.	"	(1-100)	27	23-9-29	30 c.c.	"	22-10-29	"O" virus intravenously blood H 1283 26-8-29.	Temp. reaction commenced 48 hours after injection of virus. No other symptoms.	
		"	"	34	30-9-29	30 c.c.	"	8-11-29	"O" virus intravenously Onderstepoort.	Temp. reaction commenced 48 hours after injection of virus. No other symptoms.	
		"	"	41	7-10-29	30 c.c.	"	22-11-29	2nd virus intravenously blood H 1280 6-9-29.	"	
		"	(1-400)	48	14-10-29	30 c.c.	"			"	
1295	4-year old cross-bred Arab-Somali gelding ex Gilgil.	"	(1-100)	27	23-9-29	30 c.c.	"	22-10-29	"O" virus subcutaneously spleen 1283, Toluol 3% (56 days old).	Temp. reaction commenced on 6th day after injection of virus. Maximum 102° F. No other symptoms throughout.	
		"	"	34	30-9-29	30 c.c.	"	5-11-29	"O" virus intravenously blood H 1283 26-8-29.	No reaction	
		"	"	41	7-10-29	30 c.c.	"	13-11-29	"O" virus intravenously Onderstepoort 19677.	"	
		"	(1-400)	48	14-10-29	30 c.c.	"	22-11-29	2nd virus intravenously blood H 1280 6-9-29.	"	

Lab. No. of equine experiment	Type and origin of equine	Material inoculated	Treatment of tissue	Age of material at time of inoculation	Date of inoculation	Dose and method	Result	IMMUNITY TEST		Remarks
								Date	Material and method		Result
1291	3-year old cross-bred Arab-Somali gelding ex Gilgil.	Liver ex H 1283	Formalin (1-100)	Days	9-9-29	Subcutaneously 30 c.c.	No reaction	14-10-29	"O" virus intravenously 10 c.c. blood H 1283 26-8-29.	Reacted and died of Horse-sickness on the 5th day.
1294	2-year old cross-bred Arab-Somali gelding.	Kidney ex H 1283	"	13	9-9-29	30 c.c.	"	14-10-29	ditto	do.
1293	3-year old filly by thorough-bred South African mare.	Spleen ex H 1291	(1-100) ex incubator.	4	23-10-29	30 c.c.	"	18-11-29	"O" virus subcutaneously 40 c.c. spleen 1253 3% (256 days old).	No reaction
		"	(1-400) ex incubator	11	30-10-29	40 c.c.	"	3-12-29	"O" virus intravenously 10 c.c. blood H 1291 18-10-29.	"
		"	"	17	5-11-29	40 c.c.	"	12-12-29	"O" virus intravenously 10 c.c. blood H 1283 26-8-29.	"
		"	"	25	13-11-29	40 c.c.	"	20-12-29	"O" virus intravenously 10 c.c. blood H 1308 9-12-29.	"
								2-1-30	2nd virus intravenously 10 c.c. blood H 1280 6-9-29.	"

1298	6-year old Somali mare.	"	(1-100) (Ice)	4	23-10-29	30 c.c.	"	18-11-29	" O " virus subcutaneously 40 c.c. spleen H 1253 Toluol 3% " O " virus intravenously 10 c.c. blood 1291 18-10-29. " O " virus intravenously 10 c.c. blood 1283 26-8-29. " O " virus intravenously 10 c.c. blood H 1310 10-12-29. 2nd virus intravenously 10 c.c. blood H 1280 6-9-29. " O " virus intravenously 10 c.c. blood H 1302 20-11-29. " O " virus intravenously 10 c.c. blood H 1318 29-12-29. " O " virus intravenously 10 c.c. blood H 1287 29-10-29. " O " virus intravenously 10 c.c. fresh blood H 1317. " O " virus intravenously 5 c.c. blood H 1282 1-11-29. " O " virus intravenously 10 c.c. blood H 1292 26-10-29. " O " virus intravenously 10 c.c. blood H 1288 18-2-30. " O " virus intravenously 10 c.c. blood H 1334 26-2-30.	"	ditto.
		"	(1-400) (Ice)	11	30-10-29	30 c.c.	"	29-11-29	" O " virus intravenously 10 c.c. blood 1291 18-10-29.	"	
		"	"	17	5-11-29	40 c.c.	"	9-12-29	" O " virus intravenously 10 c.c. blood 1283 26-8-29.	"	
		"	"	25	13-11-29	40 c.c.	"	19-12-29	" O " virus intravenously 10 c.c. blood H 1310 10-12-29.	"	
								28-12-29	2nd virus intravenously 10 c.c. blood H 1280 6-9-29.	"	
								7-1-30	" O " virus intravenously 10 c.c. blood H 1302 20-11-29.	"	
								15-1-30	" O " virus intravenously 10 c.c. blood H 1318 29-12-29.	"	
								22-1-30	" O " virus intravenously 10 c.c. blood H 1287 29-10-29.	"	
								29-1-30	" O " virus intravenously 10 c.c. fresh blood H 1317.	"	
								3-2-30	" O " virus intravenously 5 c.c. blood H 1282 1-11-29.	"	
								12-2-30	" O " virus intravenously 10 c.c. blood H 1292 26-10-29.	"	
								19-2-30	" O " virus intravenously 10 c.c. blood H 1288 18-2-30.	"	
								26-2-30	" O " virus intravenously 10 c.c. blood H 1334 26-2-30.	"	

Lab. No. of equine on experiment	Type and origin of equine	Material inoculated	Treatment of tissue	Age of material at time of inoculation	Date of inoculation	Dose and method	Result	IMMUNITY TEST		Remarks
								Date	Material and method	
1296	5-year old Somali mare (Heavy in foal).	Spleen ex H 1294 " " "	Formalin (1:400) (incubator) " " "	Days 4 13 19 24	24-10-29 2-11-29 8-11-29 13-11-29	Subcutaneously 30 c.c. 40 c.c. 60 c.c. 40 c.c.	No reaction " " "	22-11-29	"O" virus subcutaneously 30 c.c. spleen H 1253 Toluol 3% (260 days old).	No reaction " " " " " " " " " " "
								9-12-29	"O" virus intravenously 10 c.c. blood H 1294 16-10-29.	
								19-12-29	"O" virus intravenously 10 c.c. blood H 1283 26-8-29.	
								28-12-29	2nd virus intravenously 10 c.c. blood H 1280 6-9-29.	
								7-1-30	"O" virus intravenously 10 c.c. blood H 1302 20-11-29.	
								15-1-30	"O" virus intravenously 10 c.c. blood H 1318 29-10-29.	
								21-1-30	"O" virus intravenously 10 c.c. blood H 1308 9-12-29.	
								28-1-30	"O" virus intravenously 10 c.c. blood H 1292 26-10-29.	
								3-2-30	"O" virus intravenously 10 c.c. blood H 1282 1-11-29.	
								11-2-30	"O" virus ex H 1317, 27-1-30 10 c.c. blood intravenously.	
								18-2-30	"O" virus intravenously 5 c.c. blood ex H 1291 18-10-29.	
								25-2-30	"O" virus intravenously 5 c.c. blood H 1288 18-2-30.	

Lab. No. of equine on experiment	Type and origin of equine	Material inoculated	Treatment of tissue	Age of material at time of inoculation	Date of inoculation	Dose and method	Result	IMMUNITY TEST		Remarks
								Date	Material and method	
1300	2-year old cross-bred Arab-Somali filly ex Gilgil	Spleen ex H 1282 " " "	Formalin (1-100) (inoculator) " " "	Days 11 18 25 32	12-11-29 19-11-29 26-11-29 3-12-29	<i>Subcutaneous</i> 50 c.c. 50 c.c. 50 c.c. 50 c.c.	No reaction " " "	13-12-29	"O" virus subcutaneously 30 c.c. spleen H 1282 Toluol 3%	No reaction
								24-12-29	"O" virus intravenously 10 c.c.	"
								2-1-30	blood H 1282 30-10-29.	"
								11-1-30	"O" virus intravenously 10 c.c. blood H 1283 26-8-29.	"
								20-1-30	"O" virus intravenously 10 c.c. blood H 1289 19-10-29.	"
								27-1-30	"O" virus contravenously 10 c.c. blood H 1318 29-12-29. "O" virus intravenously 10 c.c. blood H 1292 26-10-29.	"
1301	Yearling Arab-Somali filly ex Gilgil.	Spleen ex H 1282 " " "	Formalin (1-800) (Ice) " " "	11 18 25 32	12-11-29 19-11-29 26-11-29 3-12-29	50 c.c. 50 c.c. 50 c.c. 50 c.c.	No reaction " " "	13-12-29	"O" virus subcutaneously 30 c.c. spleen H 1282 Toluol 3%	No reaction
								24-12-29	"O" virus intravenously 10 c.c.	"
								2-1-30	blood H 1282 30-10-29.	"
								11-1-30	"O" virus intravenously 10 c.c. blood H 1283 26-8-29.	"
								20-1-30	"O" virus intravenously 10 c.c. blood H 1289 19-10-29.	"
								27-1-30	blood H 1318 29-12-29. "O" virus intravenously 10 c.c. blood H 1291 18-10-29.	"
1302	Yearling Arab-Somali gelding ex Gilgil.	"	(1-1000) (Ice)	11	11-12-29	50 c.c.	Reacted and died of horse-sickness			Temperature reaction commenced on the 5th day and the horse died of acute horse-sickness on the 8th day after inoculation.

1303	2-year old cross-bred Arab-Somali filly ex Gilgil.	"	(1-400) (Ice)	11 18 25 32	12-11-29 19-11-29 26-11-29 3-12-29		No re- action " "	11-12-29 23-12-29 2-1-30 15-1-30 22-1-30 30-1-30	" O " virus subcutaneously 30 c.c. spleen H 1282 Toluol 3% " O " virus intravenously 10 c.c. blood H 1282 30-10-29. " O " virus intravenously 10 c.c. blood H 1283 26-8-29. " O " virus intravenously 10 c.c. blood H 1310 9-12-29. " O " virus intravenously 10 c.c. blood H 1287 29-10-29. " O " virus intravenously 10 c.c. blood H 1318 29-12-29.	No re- action " " " " " "	No symptoms through- out.
1304	2-year old cross-bred Arab-Somali filly ex Gilgil.	"	(1-100) (Ice)	11 18 25 32	12-11-29 19-11-29 26-11-29 3-12-29		"	20-12-29 2-1-30 15-1-30 22-1-30 30-1-30	" O " virus subcutaneously 30 c.c. spleen H 1282 Toluol 3% " O " virus intravenously 10 c.c. blood H 1282 30-10-29. " O " virus intravenously 10 c.c. blood H 1308 9-12-29. " O " virus intravenously 10 c.c. blood H 1287 29-10-29. " O " virus intravenously 10 c.c. blood H 1291 18-10-29.	" " " " "	No symptoms through- out.
1305	Yearling cross-bred Arab-Somali gelding ex Gilgil.	"	(1-800) (Incubator)	11 18 25 32	12-11-29 19-11-29 26-11-29 3-12-29	50 c.c. 50 c.c. 50 c.c. 50 c.c.	" " " "	9-12-29 19-12-29 28-12-29 7-1-30 15-1-30 22-1-30 30-1-30	" O " virus subcutaneously 30 c.c. spleen H 1282 Toluol 3% " O " virus intravenously 10 c.c. blood H 1282 30-10-29. " O " virus intravenously 10 c.c. blood H 1283 26-8-29. " O " virus intravenously 10 c.c. blood H 1310 11-12-29. " O " virus intravenously 10 c.c. blood H 1287 29-10-29. " O " virus intravenously 10 c.c. blood H 1318 29-12-29. " O " virus intravenously 10 c.c. blood H 1291 18-10-29.	Temp. reaction No re- action " " " " " "	The spleen material used for inoculation was not sterile. The temperature reaction was very mild and must be considered a doubtful reaction until further inoculations with blood collected, are made.

Lab. No. of equine on experiment	Type and origin of equine	Material inoculated	Treatment of tissue	Age of material at time of inoculation	Date of inoculation	Dose and method	Result	IMMUNITY TEST		Remarks
								Date	Material and method	
1306	6-year old gelding by thoroughbred out of South African mare.	Spleen ex H 1282	Formalin (1-600) (Ice)	Days 18	19-12-29	Subcutaneously 50 c.c.	No reaction	19-12-29	"O" virus subcutaneously 30 c.c.	No symptoms throughout.
					26-12-29	50 c.c.	"	2-1-30	spleen H 1282 Toluol 3%	
					4-12-29	50 c.c.	"	11-1-30	"O" virus intravenously 10 c.c.	
					11-12-29	50 c.c.	"	20-1-30	"O" virus intravenously 10 c.c.	
								27-1-30	blood H 1283 26-8-29.	
								5-2-30	"O" virus intravenously 10 c.c.	
								13-2-30	blood H 1287 29-10-29.	
								22-2-30	blood H 1291 18-10-29.	
									blood H 1318 29-12-29.	
									"O" virus intravenously 10 c.c.	
1313	2-year old cross-bred Arab-Somali ex Gilgil.	Spleen ex H 1282	(1-400) (Ice)	21	22-11-29	50 c.c.	No reaction	23-12-29	"O" virus subcutaneously 30 c.c.	No symptoms throughout.
					29-11-29	50 c.c.	"	7-1-30	spleen H 1282 Toluol 3%	
					6-12-29	50 c.c.	"	15-1-30	"O" virus intravenously 10 c.c.	
					13-12-29	50 c.c.	"	22-1-30	blood H 1283 26-8-29.	
								30-1-30	"O" virus intravenously 10 c.c.	
								4-2-30	blood H 1287 29-10-29.	
								12-2-30	blood H 1291 18-10-29.	
									"O" virus intravenously 10 c.c.	
									blood H 1292 26-11-29.	
									"O" virus intravenously 5 c.c.	

1314	2-year old cross-bred Arab-Somali ex Gilgil.	"	(1,400) (Ice)	21	22-11-29	50 c.c.	"	20-12-29	" O " virus subcutaneously 30 c.c. spleen H 1282 Toluol 3% " O " virus intravenously 10 c.c. blood H 1282 30-10-29. " O " virus intravenously 10 c.c. blood H 1283 26-8-29. " O " virus intravenously 10 c.c. blood H 1287 29-10-29. " O " virus intravenously 10 c.c. blood H 1292 26-10-29. " O " virus intravenously 10 c.c. blood H 1291 18-10-29. " O " virus intravenously 5 c.c. blood H 1317 27-1-30. " O " virus intravenously 10 c.c. blood H 1291 20-11-29.	"	No symptoms through- out.
1315	Yearling filly Somali ex Wilmot, Gilgil.	"	(1,800) (Ice)	27	28-11-29	50 c.c.	"	11-1-30	" O " virus subcutaneously 30 c.c. spleen H 1282 Toluol 3% " O " virus intravenously 10 c.c. blood H 1282 1-11-29. " O " virus intravenously 10 c.c. blood H 1292 26-10-29. " O " virus intravenously 10 c.c. blood H 1318 29-12-29. " O " virus intravenously 10 c.c. blood H 1317 27-1-30. " O " virus intravenously 5 c.c. blood H 1302 20-11-29. " O " virus intravenously 10 c.c. blood H 1288 18-2-30.	"	No symptoms through- out.
		"	"	36	7-12-29	50 c.c.	"	22-1-30	" O " virus intravenously 10 c.c.	"	
		"	"	48	19-12-29	50 c.c.	"	29-1-30	" O " virus intravenously 10 c.c.	"	
		"	(1,1000) (Ice)	57	28-12-29	50 c.c.	"	4-2-30	" O " virus intravenously 10 c.c.	"	
								11-2-30	" O " virus intravenously 10 c.c.	"	
								18-2-30	" O " virus intravenously 5 c.c.	"	
								26-2-30	" O " virus intravenously 10 c.c. blood H 1288 18-2-30.	"	

Lab. No. of equine on experiment	Type and origin of equine	Material inoculated	Treatment of tissue	Age of material at time of inoculation	Date of inoculation	Dose and method	Result	IMMUNITY TEST		Remarks
								Date	Material and method	
1316	Yearling by colt thoroughbred out of Somali ex Wilmot, Gilgil.	Spleen ex H 1282 " "	Formalin (1-600) (Ice) (1-1000) (Ice)	Days 27 36 48	28-11-29 7-12-29 19-12-29	Subcutaneously 50 c.c. 50 c.c. 50 c.c.	No reaction " "	2-1-30	"O" virus subcutaneously 30 c.c. spleen H 1282 Toluol 3%	No reaction
								13-1-30	"O" virus intravenously 10 c.c. blood H 1282 30-10-29.	"
								22-1-30	"O" virus intravenously 10 c.c. blood H 1308 9-12-29.	"
								29-1-30	"O" virus intravenously 10 c.c. blood H 1292 26-10-29.	"
								4-2-30	"O" virus intravenously 10 c.c. blood H 1318 29-12-29.	"
								11-2-30	"O" virus intravenously 10 c.c. blood H 1287.	"
								18-2-30	"O" virus intravenously 5 c.c. blood H 1302 20-11-29.	"
								26-2-30	"O" virus intravenously 10 c.c. blood H 1288 18-2-30.	"
								18-12-29	"O" virus subcutaneously 50 c.c. spleen H 1302 Toluol 3%	"
								2-1-30	"O" virus intravenously 10 c.c. blood H 1302 20-11-29.	"
1307	Aged Somali mare ex Gilgil in foal and with foal at foot.	Spleen ex H 1302 " "	(1-700) (Ice) " "	7 17	27-11-29 7-12-29	60 c.c. 60 c.c.	"	4-2-30	"O" virus intravenously 10 c.c. blood H 1282 1-11-29.	"
								13-2-30	"O" virus intravenously 10 c.c. blood H 1317 27-1-30.	"
								21-2-30	"O" virus intravenously 10 c.c. blood H 1288 18-2-30.	"
1308	5-months old foal Arab-Somali ex Gilgil.	"	(1-800) (Ice)	7	27-11-29	50 c.c.	Reacted and died of horse-sickness.			Temperature reaction commenced on the 7th day and the horse died of acute horse-sickness on the 13th day after inoculation.

1309	Aged Somali mare ex Gilgil.	Spleen ex H 1302 " " "	Formalin (1-400) (Ice) (1-1500)- (Ice)	19 28 38	9-12-29 18-12-29 28-12-29	60 c.c. 60 c.c. 60 c.c.	No re- action " "	7-1-30 4-2-30	"O" virus intravenously 10 c.c. blood H 1302 20-11-29. "O" virus intravenously 10 c.c. blood H 1282 1-11-29.	No re- action " "	No symptoms through- out. We have no proof that the material inoculated on 28-12-29 (<i>viz.</i> , 1-1500 formal- ized spleen) was in- activated since no control horse was available.
1310	7-months old filly Arab-Somali ex Gilgil.	"	(1-600) (Ice)	7	27-11-29	50 c.c.	Reacted and died of horse- sick- ness.				Temperature reaction commenced on the 11th day and the horse died of horse- sickness on the 14th day after inoculation.
1311	Aged Somali mare. In foal and with foal (No. 1312) at foot ex Gilgil.	" " "	(1-400) " (1-1000)	7 17 28	27-11-29 7-12-29 18-12-29	60 c.c. 60 c.c. 50 c.c.	No re- action " "	28-12-29 7-1-30 4-2-30	"O" virus intravenously 10 c.c. blood H 1302 20-11-29. "O" virus intravenously 10 c.c. blood H 1310 11-12-29. "O" virus intravenously 10 c.c. blood H 1282 1-11-29.	No re- action " "	No symptoms through- out. We have no proof that the material inoculated on 18-12-29 (<i>viz.</i> , 1-1000 formal- ized spleen) was in- activated since no control horse was available.
1312	7-months old foal Arab-Somali ex Gilgil.	" " "	(1-500) " "	7 17	27-11-29 7-12-29	50 c.c. 60 c.c.	" "	18-12-29 2-1-30 4-2-30	"O" virus subcutaneously 50 c.c. spleen H 1302 Tohol 3% "O" virus intravenously 10 c.c. blood H 1302 20-11-29. "O" virus intravenously 10 c.c. blood H 1282 1-11-29.	" " "	No symptoms through- out.

Lab. No. of equine on experiment	Type and origin of equine	Material inoculated	Treatment of tissue	Age of material at time of inoculation	Date of inoculation	Dose and method	Result	IMMUNITY TEST		Remarks
								Date	Material and method	
1317	Foal 2 months old by thoroughbred out of Somali ex Furse, Eldoret.	Spleen ex H 1308 " H 1310	Formalin (1-400) (1-500)	Days 22 34	2-1-30 14-1-30	Subcutaneously 40 c.c. 40 c.c.	No reaction "	21-1-30	"O" virus subcutaneously 30 c.c.	Reaction commenced on 4th day after inoculation. Very slight inappetence for 2 days
								3-2-30	"O" virus intravenously 5 c.c. blood H 1282 1-11-29.	
1318	Aged Somali gelding ex Wilson, Ulu.	..	..	41	..	..	..	23-12-29	"O" virus subcutaneously 30 c.c. spleen H 1282 Toluol 3%	Reaction commenced 48 hours after inoculation and horse died on the 7th day.
1319	Aged Somali mare ex Gilgil.	Spleen ex H 1308 " H 1310 " "	(1-400) (1-600)	18 31	29-12-29 11-1-30	50 c.c. 60 c.c.	No reaction "	21-1-30	"O" virus subcutaneously 30 c.c. spleen H 1282 Toluol 3%	No symptoms throughout.
								3-2-30	"O" virus intravenously 5 c.c.	
								12-2-30	"O" virus intravenously 5 c.c.	
								20-2-30	"O" virus intravenously 10 c.c. blood H 1288 18-2-30.	
1320	10-months old filly Arab-Somali.	H 1308 H 1310	(1-500) (1-1500)	18 30	29-12-29 10-1-30	50 c.c. 60 c.c.	" "	21-1-30	"O" virus subcutaneously 30 c.c. spleen H 1282 Toluol 3%	No symptoms throughout.
								3-2-30	"O" virus intravenously 5 c.c.	
								12-2-30	"O" virus intravenously 5 c.c.	
								20-2-30	"O" virus intravenously 10 c.c. blood H 1318 18-2-30.	
								26-2-30	"O" virus intravenously 10 c.c. blood H 1288 18-2-30.	

HEARTWATER (*RICKETTSIA RUMINANTII*).

By R. Daubney.

The following report on the natural transmission of Heartwater of sheep by *Amblyomma variegatum* (Fabricius, 1794), and observations on the histo-pathology, is furnished by Mr. R. Daubney, Assistant Chief Veterinary Research Officer.

The disease "heartwater" of sheep, cattle and goats, has been recognised in South Africa for upwards of seventy years, and as long ago as 1902 Lounsbury demonstrated the part played by the common "bont" tick, *Amblyomma hebraeum*, Koch, 1844, in its transmission. The virus of the disease does not pass through the egg of the tick, but a tick infected in the larval or the nymphal stages is capable of transmitting the infection when feeding as a nymph or adult respectively. Further, according to Lounsbury, a tick infected as a larva may feed upon an insusceptible host during the nymphal stage and still remain infective until the final feed as an adult. According to the South African workers, the period of incubation is about fourteen days when induced by tick-infestation and somewhat shorter when direct blood inoculation is employed. The onset of the disease is characterised by a severe febrile reaction, which may or may not be accompanied by early manifestations of hydrothorax and hydropericardium. Before death, nervous symptoms usually develop, e.g. muscular tremors, strabismus and tetanic convulsions. The nervous phenomena are much more pronounced in cases of the disease in cattle, and in fact together with the pyrexia may be considered as the typical syndrome of the disease in this species.

At death the characteristic lesion, hydropericardium, is present in only a percentage of animals, and is much less frequently observed in cattle than in sheep or goats. Other lesions found are those of an acute septicaemia, *tumor splenis*, petechial haemorrhages in the epicardium, myocardium, endocardium, and cortex of the kidney; gastritis, and injection of the blood vessels of the cerebral meninges.

Recently, Cowdry (1925) has described the occurrence of a *Rickettsia* (*R. ruminantium*) in the endothelial cells of the smaller blood-vessels of the kidney, cerebral cortex, medulla, cerebellum, spleen, pancreas, suprarenals, lymphatic and salivary glands, ovary and *corpus luteum* in animals that have died from experimental heartwater (induced either by blood inoculation or by infestation with infected ticks), or that have been killed during the febrile reaction. The organisms are

gram-negative, intracellular and coccoform, occurring characteristically in spheroid or ovoid masses in the cytoplasm of the cells. Several clumps of Rickettsiae are commonly present in a single cell, but apart from distortion of the cell or its nucleus when the masses are large, their presence appears to have no deleterious effects on the parasitised cell. Certain histological changes are regularly found in such organs as brain, kidney and liver, but these lesions, as Steck (1928) has pointed out, are in no way correlated with the presence of Rickettsia in the area where the lesions are observed or even with their existence, as far as can be ascertained by histological examination, in the whole organ. The lesions cannot therefore be considered as a reaction to the invasion of endothelial cells by Rickettsia.

Amblyomma hebraeum, the vecting tick in South Africa, has not been recorded from Kenya Colony, although the disease heartwater is widely distributed throughout the Highlands, and particular attention has been directed to a search for this species since the arrival of the writer in 1925. According to Robinson (Nuttall, Warburton and Robinson, 1926), the centre of distribution for this species is South Africa, particularly the south-eastern regions extending northwards through Portuguese East Africa to Tanganyika Territory.

Two other species of *Amblyomma*, neither of which occurs in South Africa proper, have their centre of distribution in Tropical Africa—*Amblyomma gemma*, Donitz, 1909, which extends from Somaliland in the north through Eastern Africa to Tanganyika Territory in the south; and *A. variegatum*, Fab., 1794, which ranges from Egypt and Abyssinia in the north to Portuguese East Africa in the south, occurring also on the west coast.

Morphologically, *A. gemma* resembles *A. hebraeum* more closely than any other species, and it has not infrequently been collected by the writer from cattle, sheep and goats on heartwater infected farms, usually in rather small numbers and invariably mixed with *A. variegatum*, which is a much more common species in the same districts. While it is regarded as a possible vector of heartwater in Kenya Colony, it is considered that its comparative rarity relegates it to a position of only secondary importance, and owing to this scarcity an opportunity has not yet arisen to carry out transmission experiments.

A. variegatum is by far the commonest member of the genus in Kenya, and has been suspected of transmitting heartwater ever since the disease was recognised in this country. It is, however, an extremely difficult species to rear in the Laboratory, and for this reason definite proof has been difficult to obtain. Lounsbury (1905) states that the eggs take the same time to hatch and the larvae and nymphae the same time to feed and moult as would those of *A. hebraeum* under the same conditions, but Nuttall (1915) was able to observe hatching of eggs in only two batches, which were incubated at 30° C., and all attempts to raise the larvae failed, although he was able to rear generations of *A. hebraeum* with ease. The experience of the writer accords with that of Nuttall, and up to the present *A. variegatum* has resisted all attempts at rearing in this Laboratory.

The occurrence of three cases of naturally contracted heartwater in a small fenced enclosure at the Laboratory recently afforded an opportunity to demonstrate the natural transmission of heartwater by *A. variegatum*.

Two cattle, Nos. X3386 and X3225, that had been used as virus-makers during double-inoculations against rinderpest in the field, were returned to the Laboratory on the 4th March, 1929, and segregated in a small fenced boma for some days. X3386 died on the 5th March, apparently from the sequelae of rinderpest, and X3245 died on the 18th March, 1929, from East Coast Fever.

On the 27th June, 1929, a privately-owned sheep that had been for some days in this enclosure was found dead. The lesions discovered, post-mortem, suggested heartwater as the cause of death, and by histological examination Rickettsiae were demonstrated in the capillaries of the brain and kidney. Four male specimens and one female of *A. variegatum* were removed from this sheep after death. Four days later, on the 1st July, a Laboratory sheep, No. 3077, in the same enclosure was found dead, and again the gross lesions post-mortem indicated heartwater as the cause of death. Histological examination confirmed the diagnosis by demonstrating large numbers of Rickettsiae in the brain and kidney. One male specimen only of *A. variegatum* was collected from this sheep. Sub-inoculations of heart blood of sheep 3077 intravenously into two other sheep produced no reactions. One month later, on the 5th August, cow 6074, which had been in the same enclosure for several weeks, died of heartwater; again the diagnosis was confirmed by the examination of sections

of brain and kidney. This cow had nine male and four female *A. variegatum* on her at death; the females were all attached and one was almost fully engorged. Sub-inoculations of the heart blood of cow 6074 were made into two sheep, Nos. 3225 and 3068. Sheep 3068 gave an indeterminate reaction during the third and fourth weeks after inoculation. Sheep 3225 died unexpectedly on the seventeenth day without having shown any febrile reaction. There were no lesions suggestive of heartwater, and neither Rickettsia nor lesions could be demonstrated by histological methods. Of three sheep inoculated with heart blood of sheep 3225, none showed any reaction.

In view of the fact that no cases of heartwater had occurred elsewhere on the Laboratory farms, and that *A. variegatum* cannot normally be collected from the Laboratory animals, it was concluded that the cattle X3386 and X3245 had in all probability been responsible for the infestation of this enclosure by dropping engorged nymphae. No other animals from *Amblyomma* infested districts had recently been kept in this small paddock. The possibility that one or both of these animals was infected with heartwater at the time of death cannot be excluded, since histological examinations for Rickettsia or heartwater lesions were not carried out. It is interesting to note the time elapsing between the arrival of these animals and the occurrence of the first case of heartwater—125 days, of which one month was extremely rainy. This presumably is the time required by nymphae to moult, feed and produce infection. Allowing roughly twenty-five days for the feeding and incubation periods, the nymphae apparently took some three months to complete the moult.

EXPERIMENTAL INFECTION BY TICKS.

Unfed adult ticks were next collected by placing calves in the enclosure and removing any attached ticks once or twice daily. The supply seemed now almost exhausted, since it was only possible to collect two females and ten males over a period of two weeks, and no more have been observed since that time. No larvae or nymphae of *Amblyomma* were observed at any time on any of the animals placed in the paddock after the death of the original two cattle, although a special search for the immature stages was made in every case.

Sheep 3129 and 3133 were each infested on the 7th August, 1929, with three unfed male and one unfed female specimens of *A. variegatum*, collected from calves in the enclosure. Sheep 3129 reacted on the twentieth day, and sheep

3133 on the twenty-second day. The febrile reaction persisted for five days in sheep 3133. In sheep 3129 the reaction was more severe, the temperature for four days remaining above 107° . Altogether the reaction of the animal lasted for sixteen days. Both animals recovered, having displayed no other objective symptoms.

Blood was taken from sheep 3129 on the afternoon of the 28th August, temperature of the animal 106° , and injected intravenously in amounts of 10 c.c. each into sheep 3233, 3219 and 3240. All three animals reacted. Sheep 3233 showed the commencement of a reaction on the ninth day and died on the fifteenth day; Sheep 3219 reacted on the twelfth day, and was destroyed on the fourteenth day; Sheep 3240 reacted on the twelfth day and died on the twentieth day.

Rickettsiae were demonstrated in sections of the superficial cerebral cortex and hippocampus of Sheep 3219, destroyed thirty-six hours after the febrile reaction had commenced. The characteristic lesions of leucostasis, infiltration of the pia mater, perivascular infiltration in the cortex and attraction of satellite cells by neurons were present but not marked.

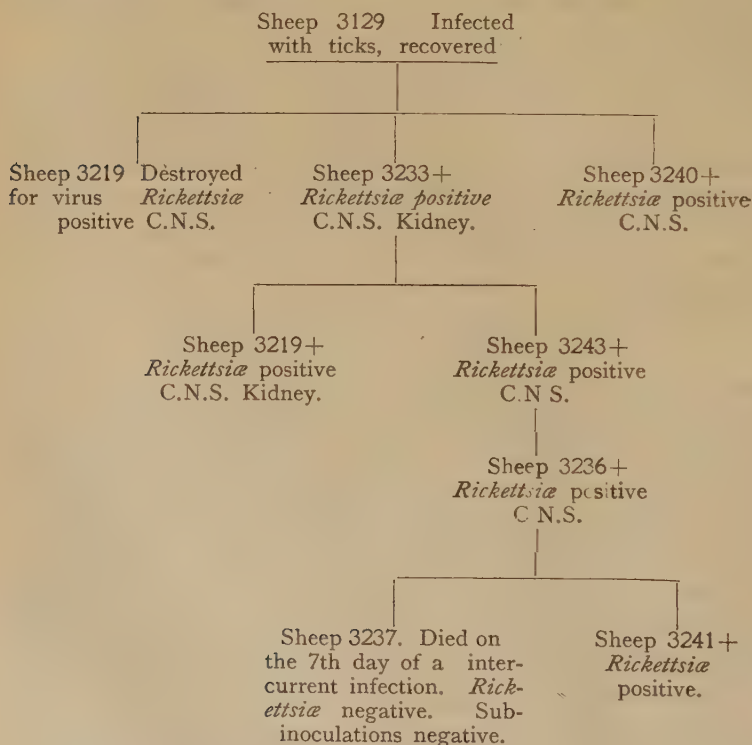
Sheep 3233 showed large numbers of Rickettsiae in sections of the cerebral cortex and kidney. Leucostasis and perivascular infiltrations were marked, but there was also an enormous infiltration into the subarachnoid space and in this exudate and also in the cells bacteria were found. On this account, the lesions in Sheep 3233 were excluded from further consideration.

Sheep 3240 survived for a period of eight days from the commencement of the pyrexia, and showed post mortem the characteristic gross lesions of heartwater. Histological methods showed that Rickettsiae were extremely rare in the cerebral cortex, over an hour's search being necessary before a single group could be found. None were found in sections of kidney. Nevertheless the usual microscopic lesions were exceptionally well marked, and it may be assumed that the severity of the changes, particularly in the central nervous system is related to the longer duration of the infection. Sections of kidney showed marked perivascular infiltration in the boundary zones, and some periglomerular cellulation. In the cerebral cortex there was marked leucostasis, perivascular infiltration and satellitism of monocytes around the neurons.

Blood from Sheep 3233 was injected intravenously into Sheep 3239 and 3243. Both these animals died on the fifteenth day after inoculation and both showed lesions and *Rickettsiae*. From Sheep 3243 a further sub-inoculation was made into Sheep 3236, which died on the thirteenth day after inoculation, and again *Rickettsiae* were demonstrated, together with infiltrative lesions of the kidney and central nervous system.

Two sheep, Nos. 3237 and 3241, were inoculated with blood from Sheep 3236. Sheep 3237 died on the seventh day after inoculation from an intercurrent infection. Examination of the kidney and central nervous system for *Rickettsiae* or lesions gave a negative result, as did also the sub-inoculation of heart blood into two susceptible sheep. Sheep 3241 died on the nineteenth day after inoculation after a reaction lasting seven days.

The strain is still being propagated for experimental purposes by blood inoculations in sheep, and shows no signs of decreasing in virulence.



The history of this strain of virus for the first four generations is shown in diagrammatic form in the text.

DISCUSSION.

The observations recorded show then that heartwater of ruminants in Kenya Colony may be transmitted naturally by the adult stages of *Amblyomma variegatum*, the common bont tick. The prepatent period after infestation with infected ticks is about three weeks; after direct blood inoculation from a reacting animal the period of incubation is usually from nine to twelve days. The findings of Cowdry (1925) with reference to the regular occurrence of Rickettsiae in experimentally infected animals are confirmed, and the Rickettsiae demonstrated in these animals agree morphologically with *R. ruminantium*, Cowdry. In their uniformity of shape and size these coccoform organisms are strikingly different from the other *Rickettsiae* that have been described as pathogenic for mammals.

For some three years, routine histological examinations of the kidney and central nervous system have been carried out at this Laboratory whenever heartwater was suspected as the cause of mortality in stock, and undoubtedly the search for Rickettsiae has enabled the staff to diagnose outbreaks of that disease that would have remained undetected by naked-eye methods and frequently unconfirmed by animal inoculations. In the course of these routine examinations certain lesions, particularly of the central nervous system, were remarked as characteristic of the disease, and it was later noticed that such nervous lesions were usually more marked in the bovine cases, a fact which agrees well with our knowledge of the symptomatology of the disease in that species. Reference has already been made to these lesions in the text of this paper, and Steck (1928) sums up his account of the lesions in the following terms: "The characteristic changes in heartwater are leucostasis and perivascular cellulation. The former occurs in all organs and the macrophage is the prominent cell, but lymphocytes and neutrophils are also numerous. The latter is pronounced in the liver, kidney, and sometimes the adrenal glands. All the cells of the mesenchyma may take part in this reaction, but mainly those of the lymphocytic series—lymphocytes and plasma cells. It seems most likely that these alterations are due to a noxe which is spread diffusely by the blood-stream. It must remain for further investigation to determine the nature of this noxe."

It is not proposed to discuss the lesions in detail in this paper, but merely to state that the findings of Steck have been substantiated in course of examination of sections from

a large number of naturally occurring cases of heartwater and from experimentally produced cases of the disease. The perivascular cellulation is usually most marked in the boundary zone of the cortex of the kidney. Leucostasis is the early characteristic change observed in sections of cerebral or cerebellar cortex. It is chiefly remarked in vessels a little larger than those in which it is customary to find Rickettsiae, and when combined with the perivascular infiltration in the kidney it is regarded by the writer as of considerable assistance in diagnosing those cases of heartwater in which Rickettsiae cannot be demonstrated. In addition to leucostasis, some evidence of perivascular infiltration can usually be found in the cerebral cortex, and occasionally there is a certain amount of cellular exudate in the subarachnoid space. A lesion which has not hitherto been described, but which is present with great regularity in cases of the disease in bovines, and frequently also in sheep when they have survived several days after the commencement of the reaction, is the so-called "satellitism" of neurons. The condition is in every way comparable to that described by various authors (Nicolau and Galloway, 1928, and others), in Borna disease of the horse, and by Metchnikoff in senility. In Borna disease it is stated that the condition may either disappear during the evolution of the disease or become intensified and lead to neuronophagia. The writer has observed occasional evidence of what appears to be true neuronophagia in cases of heartwater in cattle, but the phenomenon is rare. It may be that the "satellitism" in heartwater is merely a result of injury of the neurons by some toxin derived from the Rickettsiae, but here it will be remarked as curious that in the immediate vicinity of the demonstrable Rickettsiae there should be no evidence at all of any injury to the host cells or reaction to the presence of the organism. On the other hand, it is quite possible that the Rickettsia infection succeeds in "lighting-up" a widespread but normally latent neuro-virus, which under these conditions is capable of giving rise to the neuron lesions, and also to the nervous symptoms commonly associated with heartwater. Much the same explanation has been offered in connexion with the peculiar incidence of such diseases as herpes, postvaccinal encephalitis, etc. Further investigations, however, are necessary before the true explanation of these nerve lesions can be established.

LAIKIPIA LUNG DISEASE.

By R. W. M. Mettam.

The following report was furnished by Prof. R. W. M. Mettam, Veterinary Research Officer, of his further investigations into Laikipia Lung Disease :—

Synonyms.—Ngobit, Nanyuki and Rumuruti Lung Disease ; Infectious Pleuro-pneumonia of sheep and lambs.

Definition.—Laikipia lung disease may be defined as a specific pyogenic disease of lambs and sheep, characterised by an acute or chronic pleuro-pneumonia of a purulent type, and frequently complicated by metastatic lesions in the eyes, joints, tongue and liver. It is due to a specific bacterium.

Distribution in Kenya.—Originally described by farmers from the Laikipia district (altitude, 6,000-7,000 feet), hence its specific name, the disease is very widely distributed throughout the settled areas of the Colony, and authentic cases have been diagnosed in the following districts, e.g. Nanyuki, Nyeri, Rumuruti, Thomson's Falls, Rift Valley, Molo, Lumbwa, Uasin Gishu Plateau, etc., all of which have an altitude of 5,000 feet or more. It has not yet been observed in the Nairobi district, or in the settled areas about Machakos, or along the Nairobi-Kima railway line. Owing to the present indiscriminate manner in which sheep are moved, however, there is very little doubt that within the next few years it will be scattered throughout the Colony. Undoubtedly the disease first originated in the Laikipia-Rumuruti district, and has spread to its present extent by the movements of large flocks of sheep, either in search for grazing or as a result of haphazard purchasing of animals from already infected flocks for the stocking of farms in freshly exploited districts.

At present it cannot be definitely stated if all the native reserves are infected, but the disease has for certain been diagnosed in the flocks of the Lumbwa, Nandi, Masai, Northern and Southern Kikuyu Reserves. Its presence is suspected, but has not yet been confirmed, in the flocks of the Njemps, Suk, Turkana and the nomadic tribes of the Northern Frontier Province.

General Distribution in Tropical Africa.—The disease is widespread through the Uganda Protectorate, the Belgian Congo, Tanganyika and Nyasaland. In the last-named country the disease is said to be one of the commonest of the

sheep diseases, and an outbreak with a high mortality was recorded from the Government Farm at Namiwawa. Unfortunately, very little information was published on this very interesting outbreak.

From the available literature, it cannot be definitely ascertained whether the disease has ever been recorded from the French tropical African colonies, or from the Rhodesias. Apparently, it is quite unknown south of the Limpopo River.

Since the war there has been very extensive research into the pyogenic disease of sheep throughout the world, particularly in Australia and in the various states of South America. In no investigation has the organism corresponding to the specific bacterium of Laikipia lung disease been isolated, and it seems very certain that the organism has never been described before.

The pyogenic condition described in two such widely-separated countries as Australia and Chili, by Seddon² and Descazeaux³ respectively, are due to different organisms, although the pathology of the two diseases is so similar.

The pathology of Laikipia lung disease has a certain resemblance to the conditions described by Seddon and Descazeaux, but the organism is quite different from the bacteria they have described.

It is clear, after a careful perusal of the literature, that while pathologically the pyogenic diseases of ovines present a very similar picture, bacteriologically they are due to numerous but entirely different organisms, generally of feeble virulence.

Prevalence of Sheep Disease in Kenya.—The most prevalent sheep diseases in Kenya in order of their severity are: (1) Intestinal parasitism, (2) Laikipia lung disease, (3) heartwater, and (4) bluetongue. Sheep scab also exists on different farms in the Colony, but where it is energetically combated by systematic dipping it is responsible for very little economic loss. Of the four diseases mentioned above, both heartwater and bluetongue are more prevalent in certain parts of the Colony, depending on the susceptibility of the locality for the ecology of their invertebrate vectors, while, in addition, bluetongue is distinctly seasonable in its occurrence.

Then the importance of the internal parasites of sheep has been recognised by the Kenya farmer for many years, though it is only recently that their treatment has been

brought up to date. This is especially true of the sheep hookworm. Daubney,⁴ of this Laboratory, has just presented a brochure entitled, "The Important Parasitic Worms of Sheep in Kenya," in which the latest information on this very important subject is given in a concise manner. This publication should be in the hands of all who take an interest in the sheep industry in Tropical Africa.

Laikipia lung disease was first investigated by Whitworth of this Laboratory in 1925, during the severe mortality of lambs on two large farms in the Laikipia district. His deductions have only appeared in the report of the Department of Agriculture for 1926.

Owing to the pressure of work in other directions, mainly in connexion with the major cattle diseases of the Colony, Whitworth did not pursue his investigations very far, and the present author took over from him during the lambing season of 1927.

Very little information can be obtained on the early history of this lung disease of sheep in Kenya. It is said to have been enzootic amongst the Kikuyu sheep which grazed over the foothills of Mount Kenya at the time the first settlers penetrated on to the plateau between the great mountain and the Aberdare range. Many farmers started ranching with sheep purchased from the local natives, and gradually improved their stock by crossing the animals with stock imported mainly from South Africa and Australia. On some farms, however, native sheep have never been allowed to breed with the European animals, and it was on two of these farms that the disease was originally investigated by Whitworth.

It is an important epizootological fact that some of the best bred sheep in the Colony are farmed in a district where the disease has existed for some considerable time amongst the indigenous stock.

Besides the four diseases mentioned previously, there are no other conditions which take a heavy toll of sheep life in this Colony. Sheep are remarkably free from protozoan diseases, though Schellhase,⁵ in Tanganyika, described both anaplasma and piroplasma in the blood of sheep and goats.

Of the major cattle diseases, only rinderpest may possibly infect sheep and goats, though in this Colony it is stoutly maintained that under field conditions these animals never

contracted the disease. Experimentally both species of animals may be affected by the inoculation of virulent blood, and at one time goats especially were used locally for the production of blood virus for the double-inoculation of pure-bred cattle. The procedure was discontinued apparently because the animals often reacted indifferently to the virus, and then their blood was found to have a very low potency.

Rinderpest in sheep and goats is manifested pathologically by changes in the thoracic viscera, but the pneumonia is of the lobular type and seldom complicated by abscess formation.

Finally, it may be pointed out that it seems that if a suitable breed of animal can be found capable of outstanding local conditions, there is no reason why the sheep industry should not become of first-rate importance in this Colony, as most of the ovine diseases at present enzootic are amenable not only to control but even to suppression.

Present Knowledge of Infectious Lung Diseases of Sheep.—Undoubtedly the most infectious pneumonia of sheep and lambs is found in the disease known as septicaemia haemorrhagica—which, fortunately, does not occur in Kenya.

In Southern Africa there is a chronic pneumonia of obscure etiology, known colloquially as "Jagsiekte," which has many points of resemblance with the disease known in certain parts of North America as "progressive pneumonia."⁸ Considerable attention has been paid to these two diseases by workers in both continents, and recently Cowdry and Marsh¹⁰ have compared the two conditions from every aspect. Despite a careful watch for two-and-a-half years, this peculiar disease has not been observed in this Colony, but it may be encountered sooner or later, as many sheep are imported from South Africa and very few symptoms are observed during life.

Other infectious diseases of sheep in which there are pronounced pulmonary lesions include caseous lymphadenitis, which is at present being exhaustively reinvestigated by Seddon,² in Australia; streptococcic pleuro-pericarditis, recently described by Carre³ in France; pyobacillosis of sheep, in Chili, investigated by Descazeaux;¹¹ and the pyaemic condition observed in Denmark and Sweden, and just published by Magnusson.¹² All these authors cite lesser-known investigations carried out in different parts of the world, and a large number of organisms have been inculcated as capable of producing serious attacks of sheep diseases in which the thoracic viscera

are extensively affected. During the present paper, the four authors mentioned above will be liberally quoted from, since the conditions they describe are not unlike the disease known locally as Laikipia lung disease.

All the usual text-books of veterinary medicine contain very meagre information on the respiratory diseases of sheep with the exception of the so-called ovine pseudo-tuberculosis or caseous lymph-adenitis. There are, however, scattered throughout various French and German veterinary periodicals numerous papers on this subject, and some of them are really of great importance. The names of many of the papers are set out in the bibliography.

EPIZOOTIOLOGY OF LAIKIPIA LUNG DISEASE.

Nature of Disease.

Laikipia lung disease runs a peracute course in lambs and yearlings, and is generally chronic in adults. Undoubtedly the acute form is attended by a very high mortality, and 20 per cent to 75 per cent of all sick animals may die. The fate of those which recover is still obscure, since it is not yet known if recovery is complete or if a chronic pneumonia supervenes and is responsible for the development of those cases known as "lungers," which are nearly always found in badly affected flocks. Under adverse conditions, these chronic cases may relapse, develop acute pneumonia and die after a very brief course. Such relapses have been actually observed experimentally to follow great fatigue, shearing or clipping and subsequent exposure to cool or inclement weather. Several experienced sheep farmers have corroborated this experience. In many cases, however, it is impossible to explain why "chronic lungers" relapse into acute pneumonia, but in certain instances circumstantial evidence strongly pointed to such agents as over-exertion, debility or cachexia due to drought conditions, or heavy helminth infection.

A certain percentage of acute cases apparently completely recover, for if their lungs are examined a few months after convalescence they may be entirely free from lesions.

Role of the "Chronic Lunger."

It is very well known that in bovine pleuro-pneumonia the "chronic lunger" plays an insidious but important part in the propagation and maintenance of the disease in herds.

There is no doubt that in Laikipia lung disease a similar state of affairs exists, and that the chronic lungers, very frequently an apparently healthy if unthrifty animal, is and has been in the past wholly responsible for introducing and maintaining infection in a flock.

Two instances may be quoted in illustration, namely: (a) a recent outbreak in the Lumbwa district; and (b) an outbreak in the Thomson's Falls area.

In the former case there were about 400 grade merino-Romney Marsh sheep on the farm, which was situated in a clean district. These animals contained a large percentage of lambs, three to four weeks old (unfortunately, no exact figures are available). The farm was 6,600-7,000 feet above sea level, and the grazing was fair, though the season had been unusually fine.

Some three weeks or so before the Laboratory was apprised of the mortality, a new flock of apparently healthy adult ewes arrived on the farm, having been purchased from a sheep farmer in a notoriously dirty district. Within two or three weeks after arrival on the farm, the disease broke out with great violence amongst the lambs, and caused a heavy mortality (no figures are available). There were no squatter sheep or goats on the farm, and it is clear that infection must have been introduced by some of the new purchases, which contained the specific organism in their discharges. As will be mentioned later, it has never been proved that healthy animals can carry the organism without the presence of any pyogenic lesions, though chronic lungers may eject the organism in their faeces and nasal discharges.

A very similar history was obtained in the Thomson's Falls outbreak. The disease had never previously been encountered by the farmer, but after the purchase of apparently healthy adult ewes from the Laikipia district, and mixing them with his own clean flock of lambs and yearlings, the disease broke out within a month, and eventually caused a mortality of 40 per cent amongst his young stock. Obviously the only possible explanation in this case was that infection was imported with the new purchases.

In both outbreaks there was no history of any of the new arrivals having broken down into acute lung disease, which might possibly happen when chronic lungers are over-excited during the drive from one farm to another.

In other instances, however, adult sheep, which were subsequently proved to have been "lungers," completely failed to set up the disease when intermingled with highly susceptible stock. This was noticed several times at the Laboratory, when cases sent in from the field were placed in close contact with lambs born on the premises.

Nevertheless, it is obvious that chronic lungers are a source of danger, and great care should be exercised before new purchases are mixed up with clean home-born stock.

The Disease amongst Squatter Animals.

There is always a tendency to blame squatter animals. In the writer's opinion, this attitude is justifiable, for the infectious respiratory diseases of cattle, sheep and goats are literally rampant amongst most native herds and flocks. On certain farms, however, in the Laikipia district, where no fresh introductions are made from other European sheep farmers and where there are no squatter stock, the disease can only be maintained by chronic lungers, or possibly by animals which harbour the organism in their bodies without any morbid pathological lesion in their respiratory organs.

No accurate estimate can be offered on the prevalence of the disease amongst native and squatter sheep, as no detailed investigations have ever been conducted in the reserves, but there is no doubt that in all the reserves in which sheep are kept both the incidence and mortality are very great.

The policy of permitting squatter stock on European farms is a very much debated one, the pros and cons of which cannot be discussed here, but it cannot be too often emphasised that unless squatter stock is rigidly supervised they are a very great source of danger from the disease point of view for the more highly-bred animals of European settlers.

Susceptibility of Various Animals.

It is widely held that each of the ruminant domestic animals in Kenya has its own specific infection. This view is true in the case of bovine pleuro-pneumonia, but it cannot be accepted in the cases of sheep and goat diseases.

In contagious pleuro-pneumonia of goats, especially when the disease is particularly virulent, sheep are affected and show the characteristic lesions of the disease as they are found in the goat. This observation was recently made at Kabete on animals obtained from the Kikuyu Reserve.

Goats are both naturally and experimentally easily affected with Laikipia lung disease. During 1927 a sick native goat was sent to the Laboratory from a farm in Laikipia on which squatter goats were kept, and on which the disease had recently ravaged amongst the lambs (of the settler). A few days after arrival at Kabete, the goat died, and on autopsy showed the characteristic lesions of Laikipia lung disease from which the specified organism was recovered.

Goats are also readily infected experimentally with the organism. The observation on the native goat from Laikipia was confirmed during the investigation on the Uasin Gishu Plateau some months later into a serious outbreak of lung disease on a sheep farm. There were no squatter sheep, and no recent purchases of sheep from other districts were reported. There was, however, definite evidence that Laikipia lung disease had caused heavy loss amongst the squatter goats on the farm just previous to the mortality suffered by the European owner.

It is clear that both sheep and goats suffer from Laikipia lung disease, and that the latter animal is a serious menace to sheep farmers on account of its susceptibility to the disease. Cattle succumb to experimental inoculation of the organism, but they cannot be regarded as susceptible animals.

As regards sheep, the disease attacks all varieties and breeds of animals. Pure-bred suffer the greatest, but when an outbreak is very virulent, no particular type of animal is spared. As mentioned in the definition, in lambs the disease runs an acute course, whereas in adults it is mainly chronic in character.

Transmission in the Field.

Under natural conditions it cannot yet be definitely stated how the disease is transmitted. Experimentally, positive results follow after inoculation of the organism or of morbid material through any of the usual channels.

The rapidity with which the disease appears in susceptible animals after the introduction of a lunger suggests that infection is either aerogenic or carried by blood streams to the lungs from the intestinal canal. Apparently most of the contagious pneumonia arise from aerogenic infection, though it may be difficult to prove, e.g. contagious bovine pleuropneumonia, in which positive results may only follow the drastic but ingenious method of Nocard.

There is another possibility in lambs, namely, that infection may occur through the navel as the result of contamination of the umbilical stump soon after birth by infected material. This is said to occur in caseous suppuration of lambs in which there are acute thoracic lesions and in the pyobacillosis of Descazeaux. Experimentally, however, intra-umbilical inoculation of large doses of the *Laikipia* organism failed to set up thoracic lesions, though the lambs usually died from the intoxication.

The *Laikipia* organism does not thrive outside the body; it grows poorly at ordinary temperature, and does not culture media in four to six weeks. It is therefore apparent that if the disease results from soil infection, there must be constant heavy contamination with organisms freshly derived from the living body. The biology of the organism undoubtedly favours the theory of infection by the actual contact of susceptible animals with these disseminating virulent bacteria, and this leaves open the question whether the micro-organism reaches the lung direct or by the blood stream.

As regards the distribution of the organism in the body of sheep, it is definitely known that (a) they are present in large numbers in the nasal discharges of acute cases and of lungers, which cough up purulent material from their lungs, and (b) that they exist in the contents of the alimentary canal of acute and chronic cases, especially the former, in which there is more or less continual swallowing of pulmonary material which is not coughed out or blown out of the nose. In acute or subacute cases, plugs of muco-purulent material may be easily found at different places along the intestinal tract. These plugs contain millions of the specific micro-organism.

Examination of the milk of ewes suffering from either the acute or chronic form of the disease failed in every case to reveal the organism, so that it seems certain that the dam does not transmit the disease to her offspring in her milk.

The faeces of *normal sheep* on infected farms does not contain the *Laikipia* organism. Although this observation was only made on a limited number of animals, it is of interest in that it eliminated the "carrier," i.e. the healthy animal which disseminated the organism all over the place without showing any lesions in its own body. It is recommended, however, that fuller and more extensive investigation should be made into this problem.

According to Carre,¹ enormous numbers of Preisz-Nocard bacilli may be present in the bowel-contents of healthy animals, and be voided on to the veldt, boma floors, etc., with the faeces. Carre believes that the repeated soiling of the veldt by sick animals and by healthy carriers is an important factor in the epizootiology of caseous-suppurative of sheep.

The two cardinal conditions imperative for the successful outbreak of an infectious disease are (a) that the organism should possess a certain virulence, and (b) that the animals should be sufficiently susceptible.

It will be noticed in discussing the etiology of Laikipia lung disease that the specific organism is of comparatively low or feeble virulence; and it is maintained that for them to gain a footing in the respiratory tract of lambs there must be very important secondary, subsidiary or predisposing factors at work which decrease the resistance of the respiratory tract and facilitate the attack of a pathogen of feeble toxicity.

It is very well known that the auto-sterilising power of the normal intact respiratory mucosa is very great bacterial agents introduced into the bronchial tubes, trachea, and even into the nasal chambers, are readily got rid of. When, however, the mucosa is damaged by a variety of agents the entry of bacteria into the tissues is greatly facilitated. An illustration is found in canine distemper, in which certain saphrophytes of the normal respiratory tract becomes pathogenic and causes lesions in the lungs, whose resistance has been impaired by the filtrable virus, the real cause of the disease.

The normal sheep respiratory tract has its own peculiar normal saphrophytic flora, but the Laikipia organism is not one of them. Certain possible predisposing causes which may act under field conditions will now be noticed.

Predisposing Factors.

(a) It has been suggested that deficiency in Vitamin A either in the grazing or in the milk of the ewes, may be a predisposing cause in the pathogenesis of such lesions as the tongue abscesses, enteritis, arthritis, and broncho-pneumonia lesions, one or more of which are found in Laikipia lung disease. It is well known that feeding on rations lacking the anti-infective factor (Vitamin A) leads to metaplastic changes in the respiratory epithelium, which thereby loses its cubital or columnar character, and becomes squamous in type. During these changes the respiratory tissues are exposed to

attacks of organisms of low pathogenicity, and it is usual for numerous broncho-pneumonia abscesses to develop. The recent paper of Green and Mellanby¹⁸ is of very great importance and interest to an investigator in respiratory diseases of animals, but unfortunately it is not possible to give any practical or first-hand experiences on the relation of Vitamin A to the common suppurative lesions of the domestic animals. The intake of Vitamin A by a pregnant ewe is mainly derived from fresh green pasturage, and it is easily seen how little must be the amount when the animal is grazing on a parched or drought-stricken veldt. Mellanby and Green¹⁸ think "that the study of the etiology of some infective condition cannot be complete without including the consideration of this dietetic factor." Unfortunately, the lack of Vitamin A as a predisposing factor in the development of lung disease has received little attention during this present investigation, but it is strongly urged that the subject should be taken up with the whole-time co-operation of a bio-chemist.

The writer firmly believes that lack of Vitamin A is of fundamental importance in connexion with the development of those innumerable suppurative conditions which exist in various animals in this Colony, and which, at the present time, cannot be explained on purely bacteriological grounds, as they are nearly always due to organisms of very low virulence.

(b) Hookworm infection is probably the most serious disease of sheep in Kenya. Up to a few years ago it was responsible for very serious loss every year, but not so much from the actual mortality it caused, and that was high enough, but for the large number of poor, weakly, unthrifty lambs which existed if they recovered from the infection. Such animals were, of course, hyper-susceptible to every other condition, including Laikipia lung disease, for it was known that the two diseases often prevailed on the same farms.

It has been recorded by farmers and field officers that the energetic campaign successfully instituted against hookworm has resulted in a better type of lamb, and, it is interesting to note, a very appreciable diminution in the incidence of lung disease.

This, of course, is in accordance with the present conception that as the specific organism is of low pathogenicity the predisposing factors are of prime importance. Should therefore influencing agents be controlled or totally eliminated the prevalence of lung disease will be very materially reduced.

(c) Undoubtedly a very important predisposing agent is dust. When inhaled in any quantities it is capable of causing severe respiratory lesions. Even in man the continual inhalation of air containing large quantities of a fine dust gives rise to grave pulmonary trouble which, when complicated by an invasion into the damaged tissues of the tubercule bacillus, ends in the well-known disease, "miners' phthisis," formerly so prevalent on the gold mines of the Witwatersrand.

Silicosis of the lungs may be produced in experimental animals by the procedure known as "dusting," but it is very doubtful whether this extreme lesion ever occurs *per se* under natural conditions.

At certain seasons of the year, when the grazing is very low, sheep are forced to feed very close to the ground, and undoubtedly take in a certain amount of dust. When any number of animals are driven together over a dry veldt they envelop themselves in a cloud of dust, and it is quite impossible that inhalation of a certain amount of dust does not occur.

Reference to the literature shows that Marsh¹⁵ believes that the inhalation of dust plays an important role in injuring the lungs in cases of progressive pneumonia of sheep in Montana, and thereby predisposing those organs to the attack of micro-organisms of particularly feeble pathogenicity, e.g. various pasteurella, diphtheroids, etc. Although the pathology of progressive pneumonia and Laikipia lung disease is totally different, yet as regards their epizootiology the two diseases have very much in common. The disease, "Jagsiekte," of South Africa, described by Mitchell,⁷ is very similar to the progressive pneumonia of Montana, and an important predisposing factor in its pathogenicity is said to be inhalation of dust which facilitates the proliferation of organisms of feeble virulence in the injured lung tissues.

It must not be lost sight of, however, that whereas both jagsiekte and progressive pneumonia run a prolonged chronic course, the great majority of cases of Laikipia lung disease are of a peracute or acute type, especially in lambs.

That, however, the question of inhaled dust does cause serious mortality in this country may be gathered from the following investigation, which was recently carried out in the Rift Valley, viz. :—

"During the dry season of 1929, just before the beginning of the long rains, a large flock of sheep, numbering some 1,300 animals, was driven from a farm in the Rift Valley,

where there was practically no grazing, on to the slopes of the Aberdare Mountains, on which there was still some grass. The trek took place along one of the main roads, which was more than ankle deep in dry powdery dust. The total distance travelled was forty miles, and it only took the sheep four days to reach their destination. During the whole journey the sheep were literally enveloped in a 'dust screen.' Within two days of arrival, animals commenced to die and within a week ninety-seven deaths were recorded (7.6 per cent). The mortality was only present in the newly-arrived flock, as a further herd of some 4,000 animals belonging to the same owner, which were grazing over the same land, were in excellent condition.

"The owner examined about fifteen carcasses, and in every one found an extensive bilateral consolidation of the anterior lobes of both lungs. He at once suspected Laikipia lung disease, and asked for assistance. A further twenty carcasses or more were post-mortemed by the writer who, in every case, found identical lesions, but they were obviously not those of Laikipia lung disease. Bacteriologically the lungs revealed the presence of no pathogenic organisms; indeed, many of the lungs were quite sterile, but in the hepatised lungs, in the bronchial glands and in the abomasum, large quantities of inhaled or swallowed dust were observed, even by naked eye examination."

This investigation will be described more fully at a later stage, but sufficient has been quoted here to show that pneumonia, due to extreme inhalation of dust, does occur in Kenya, and may be attended with such a serious mortality that the outbreak resembles that of an acute infection. It is reasonable to believe that, if dust *per se* is capable of causing fatal cases of pneumonia, outbreaks of lung disease may be readily set up by the inhalation of dust impregnated with the specific organism of Laikipia lung disease, especially in districts where the soil of sheep kraals, bomas, etc., is constantly being recharged with the organisms through the media of dejecta of diseased animals. In Africa the inhalation of dust is probably a very frequent predisposing or complicating factor in the pathogenesis of respiratory affections.

Geological, Seasonal and Climatic Influences.

All the sheep farms in Kenya on which lung disease has been diagnosed are over 5,000 feet in altitude. Thus, although they lie under the Equator, they enjoy a comparatively temperate climate. At certain seasons of the year, however, the

days are hot and sunny, while, at the higher altitudes, the nights are really cold and often have a tinge of frost, especially in the vicinity of Mount Kenya.

Sheep are nearly always kept out in the open at night-time in all weathers, and undoubtedly they are often exposed to great variations of temperature within a comparatively few hours.

When the grazing is low, a supplementary ration of crushed maize, cake and pollard is offered on many farms, but it cannot be denied that in certain districts the animals suffer considerably from external conditions.

No hard and fast statement can be made on the time of the lambing season, as the rainy periods vary in different parts of the Colony. As a rule, lambing occurs in April and May (which fall during the long rains), or during October and November, at which time the short or grass rains are due to begin. The present tendency is for the majority of sheep farmers to lamb down in the October-November season. At any rate, judging from information supplied by sheep farmers from various parts of the Colony, Laikipia lung disease is at its worst during the months of June, July, December and January, i.e. roughly for about two months subsequent to the termination of the lambing seasons.

As regards telluric influences, very little can be said at this stage, as only a preliminary survey has yet been carried out on the soils of the Colony. Judging from the work of Gracie and Burton¹⁶ however, it seems as if red soil or black cotton soils are found in the localities where the disease is most prevalent, especially the latter type, which is found in what may be termed the "home of the disease," i.e. the West Kenya-Nanyuki-Laikipia district.

As the subject of the inter-relationship of the telluric conditions of any country and the epizootiology of indigenous diseases is so very obscure, it is not intended in this paper to discuss the matter any further.

SYMPTOMOLOGY, COURSE AND COMPLICATIONS.

Period of Incubation.

Under natural conditions, the period of incubation cannot always be determined, but in new-born susceptible lambs symptoms of disease have been recorded as early as seven to ten days after birth. Many cases appear during the third to sixth week of life. The disease is essentially one of the lamb or yearling.

Experimentally, inoculation of the specific organism produces very acute symptoms within twelve hours when introduced into the lungs, either directly through the thoracic wall or by intra-bronchial insufflation. By the usual routes, however, the average period is seventeen days, but it may be as long as twenty-seven to sixty days. The period of incubation in chronic cases can only be determined in those animals which originally developed the acute form of the disease.

The symptoms may be (a) acute, or (b) chronic.

Symptoms of Acute Laikipia Lung Disease.

The animal is obviously very ill, and presents very marked systemic disturbances. It stands apart from its fellows with head depressed, back slightly arched and with a harsh dry erect coat.

There is marked fever, which fluctuates between 104° and 108° F., while the pulse is at first very full and rapid, gradually becoming, as the disease progresses, weaker and more thready.

There are present all the characteristic symptoms of an acute pneumonia, e.g. rapid respirations up to 100 or so per minute of a laboured nature, and accompanied by much groaning, grunting and grinding of the teeth. The ribs appear fixed, and there is a very noticeable heaving or bellows-like action of the flanks.

A nasal discharge is always present. At first of a watery nature, it rapidly becomes foetid and muco-purulent, blocking up the anterior nares and clinging to the alae nasi, thereby greatly aggravating the respiratory difficulties. The animal tries to relieve its distress by licking away, rubbing away or blowing away the slimy material at the entrance to its nostrils. At the same time there is salivation and lacrimation, the latter being of a muco-purulent character. There is always very pronounced coughing, which is of a soft, moist character, and often paroxysmal.

The eyes are expressionless or heavy, and there is a certain degree of ptosis and photophobia.

All the visible mucosae are much swollen and deeply injected, varying in colour from a rose-pink to a deep reddish-purple, the latter being present in very peracute cases or in the final phases of the disease. It is always of serious import, for it indicates a severe degree of cyanosis.

When the respiratory distress is very great or when the nasal discharge is particularly profuse, the animal breathes through its open mouth, as if threatened with asphyxiation.

There is complete anorexia, but the animal is very thirsty and drinks large quantities of water. As a rule, it either stands apart in a most dejected attitude, quite regardless of its surroundings, or it lies down continually.

In peracute cases, all the above symptoms are noticed in a greatly exaggerated degree, or the animal may be found dead without having shown any clinical symptoms at all.

Course of the Acute Form.

The course of the acute disease varies from two or three days up to ten or fourteen days or so. The longer the course the more likelihood there is of the patient recovering or developing the chronic form of the disease.

In fatal cases there is no diminution in the severity of the symptoms; in fact, they may be all greatly exaggerated. Blood may appear in the nasal discharge, giving a "rusty" or "prune" colour, while the coughing and respiratory distress may be so marked that the animal appears to be on the verge of instantaneous suffocation.

In some outbreaks the less woolly parts of the skin appear to be much pinker than normal. It was these which originally led many farmers to believe that the disease was the same as or closely related to sheep-pox, but there are no typical variolar lesions present. Moreover, the two diseases can be easily differentiated by experimental inoculation, as will be seen when diagnosis is discussed.

In some cases, after a preliminary constipation, there supervenes an intermittent diarrhoea, dark in colour, of a disagreeable odour. It causes extensive soiling of the wool over the hindquarters and perineum region.

Complications of Acute Laikipia Lung Disease.

(a) *Acute Arthritis*.—As arthritis of one or more joints is the most common complication, though it only occurs in 1 to 5 per cent of all cases and is more common in certain districts than others. The joints commonly involved are (in order) : stifle, carpus, hock and shoulder, followed by elbow, hip, and the pharyngeal articulations.

Clinically, there are all the symptoms of acute arthritis, i.e. swollen, hot and painful condition of one or more joints, great lameness, and, if more than one limb is involved, the animal may be so crippled as to be unable to progress at all.

In extreme cases a particular limb may be very swollen, hot and painful, indicating the involvement of some of the tendon sheaths.

“ Open joints ” have been observed, but are rare. When present they show a muco-purulent discharge, inter-mixed with a small amount of synovia.

(b) *Buccal Lesions*.—In one extensive outbreak on the Ngobit division of Laikipia, many animals showed very extensive necrotic lesions of the tongue, palate and gums, simulating necrotic stomatitis of calves, which is such a widespread affection in this Colony. The lesions were often up to 3 cm. in diameter, more generally spherical in shape, and contained soft, broken-down debris. As a rule the largest ones were found on the tongue, on the dorso-lateral aspect or near the fraenum. When situated on the palate or gums they were smaller, more irregular in shape, and much more shallow.

Clinically, they were indicated by very great salivation, complete anorexia, marked tenderness of the mouth region, and by a peculiar disagreeable odour. In some cases, however, so slight were the lesions that there were no marked clinical symptoms and nothing abnormal was suspected until the animal was post-mortemed.

Cases in which necrotic mouth lesions were diagnosed during life nearly always died.

Very rare similar lesions were observed in the wall of the pharynx, larynx or even in the trachea.

(c) *Acute Ophthalmia*.—This is a very rare complication of acute cases, but it is occasionally observed. The first indication is that the animal is partially or completely blind. At the same time there are the usual concomitant disturbances of the lacrimal apparatus with ptosis and photophobia.

Clinical examination of the eyes is often quite negative, but in most cases there is a hypopyon or suppurative panophthalmia. Rarely the cornea ulcerates, and there is leakage of pus from the anterior chamber.

The fate of the eye in acute ophthalmia varies. There may be complete resorption of the exudate, and a return of normal vision, but generally a variable degree of impaired vision or blindness remains.

The condition may be unilateral or bilateral.

(d) *Other Complicating Lesions.*—When other complicating lesions occur they generally do not give rise to any clinical symptoms during life, and are only found at autopsy. In every investigation made by the writer, special attention was paid to the possibility of the presence of an acute suppurative omphalo-phlebitis, but none were ever found, though even now it is not accepted that this lesion does not frequently occur.

Multiple abscesses in the liver were found in about 1 per cent of cases, but they never gave rise to clinical symptoms during life.

Symptoms of Chronic Laikipia Lung Disease.

This form of the disease appears in adults. Uncomplicated cases may escape discovery for years and their importance from an epizootiological point of view has already been discussed.

Unfortunately, it is not definitely known if chronic cases always result from an acute attack of the disease or if they can develop independently as a result of a chronic or prolonged intoxication with the specific organism.

A chronic case is always in poor condition, and cannot be got to improve despite attention to its diet. It is generally stunted, but it enjoys a good appetite, and it may show so few symptoms that it is merely regarded as a "bad doer." On farms where parasitic diseases are prevalent it may be regarded as a case of oesophogostomiasis, and indeed the two diseases may exist in the one animal at the same time.

There is nearly always a chronic slimy nasal discharge. Here again the importance of this symptom may be overlooked, as unfortunately quite a high percentage of otherwise very sound sheep in this Colony suffer from "snuffles" or "snotty nose," which is apparently due to heavy oestrus infestation.

The daily temperature may show remarkable diurnal fluctuations, sometimes of as much as ten or twelve degrees. The charts show curves typical of an extensive but chronic suppurative condition, i.e. a practically normal morning temperature followed by a rapid ascent during the afternoon.

Other animals may show a cough, dry, harsh and paroxysmal, especially after unusual exertion.

As a rule, however, the symptoms are very vague, and chronic cases may remain undetected for a long time.

The accumulated evidence of persistent cachexia, especially on farms where anti-helminth remedies are vigorously employed, chronic profuse nasal discharge, coughing on exertion, etc., clearly points to a chronic respiratory disease, which will most certainly be confirmed on post-mortem examination.

Relapses of such chronic cases, which are regarded as "chronic lungers," are quite common, and death generally occurs from a freshly superimposed pneumonia. In these animals there is always distinct pathological evidence of the lesions of the chronic lung. The conditions under which relapses occur have already been noticed.

True, uncomplicated cases of chronic Laikipia lung disease may therefore be exceedingly difficult to diagnose during life, but there is very little doubt about the nature of the disease when there are clinical manifestations of chronic respiratory trouble coupled with persistent lesions in the eyes, joints or internal viscera.

Complications of Chronic Laikipia Lung Disease.

(a) *Chronic Arthritis.*—One or more joints, implicating one or more limbs, may be involved. The affected articulations show considerable periarticular thickening, and a more or less severe degree of ankylosis. If the carpi are affected the animal may be found in the kneeling position, either to move about or to facilitate grazing. Similarly, if the hocks or stifles are diseased, the animal has a stiff swinging gait, and may be most unwilling to move. If only one limb is affected, the animal carries the particular limb during progression.

On actual manipulation the joints are swollen, show no heat, appear callous, and the range of normal movement is limited.

These arthritic lesions may clear up spontaneously, or they persist unimproved during the rest of the patient's life, causing permanent lameness or stiffness, depending on the site and severity of the arthritis.

(b) *Lesions of the Internal Viscera*.—As mentioned before necrotic buccal lesions have only been seen in young lambs suffering from the acute form of the disease. Chronic suppuration and necrosis of the pharyngeal lymphatic glands has been observed in a few rare cases, causing stenosis of the upper respiratory passages. The pus of these glands was always foul and dark brown in colour; never the characteristic green colour of the pus in caseous suppuration of Carre.

As regards eye lesions, they were never very marked. Occasionally a chronic lunger was found with impaired vision or totally blind. Chronic hypopyon or pan-ophthalmia was not observed. Iritis was observed in a few cases.

Finally, chronic purulent foci were sometimes encountered in the liver and kidneys, but their bacteriological flora was often very mixed, and showed them to be due quite frequently to the Preisz-Nocard organism.

THE ETIOLOGY OF LAIKIPIA LUNG DISEASE.

The organism which was isolated from every acute case of acute Laikipia lung disease and also from its concurrent complications is a gram negative pleomorphic non-sporulating non-motile bacillus.

It was very seldom obtained in pure culture from the various lesions, the contaminants being a gram-positive diplo-streptococcus, which will receive further mention at a later stage, an organism indistinguishable biochemically and morphologically from *B. bronchisepticus ovis*, various staphylococci, actinomyces necrophorus, occasional anaerobes, and bacilli of the colon type, etc.

Many of the aforementioned micro-organisms are not only the usual contaminants of an ordinary suppurative lesion, but some of them are saphrophytes of the respiratory tract of healthy sheep. The Laikipia organism was never recovered from the air passages of animals in normal health.

Morphology of the Laikipia Organism.

(a) *In the animal body*.—The organism is very pleomorphic, presenting coccoid, cocco-bacillary and short bacillary forms. Their average length varies between .75 micron and 1 micron; they are delicately curved, with pointed or rounded ends. They occur in small clusters or islets, and are irregularly arranged, but sometimes a few are placed parallel to one another, resembling the "tooth-combed" appearance of the Preisz-Nocard bacillus.

(b) *On culture*.—Pleomorphism is more marked than in the animal body. In liquid media, free from carbohydrates, the formation of acid retards the rapidity of growth and causes the appearance of many gross involution forms. An abundant supply of oxygen is absolutely essential, as the organism is an obligatory aerobe. If anaerobiasis is only partial, colonies appear, and are characteristic though small in size.

Growth in Liquid Media.

Ordinary Bouillon.—The liquid becomes uniformly opalescent, while on its surface a delicate pale bluish-grey pellicle forms, which is easily broken up into lumps when the tube is shaken and sinks to the bottom. The pellicle may be so scanty that only a bluish ring appears on the side of the tube. In old cultures the pellicle becomes thicker, light-brown in colour, and is easily broken up. A deposit is also present, and increases in amount after the first three days of growth. It has a tenacious viscidropy nature, and is very difficult to dissociate. No gas. Odourless.

Serum Broth.—No surface growth. No gas. Odourless. Deposit is brown in colour, and of a mucoid granular nature and easily broken up. It increases in amount as time passes, and becomes finely granular or sandy; it tends to be lumpy, but is never as tenacious as in ordinary broth.

The body of the liquid is less turbid than in ordinary broth.

Glycerine Broth.—Growth resembles that in ordinary broth, but is generally less marked. Pellicle is not well developed. No gas, and odourless.

Glucose Broth.—There is a very considerable dirty but fine granular deposit which, when the tube is shaken rapidly, diffuses into the body of the liquid, discolouring it. Pellicle formation is generally absent; when present it is only feebly developed. No gas and odourless.

Milk.—No growth.

Von Hibler.—No gas, no deposit, meat not altered. Broth becomes slightly turbid and a delicate pale greyish ring is deposited on the glass at the level of the surface of the liquid.

Growth on Solid Media.

Ordinary Agar.—The growth generally has a moist macreous or iridescent appearance, and is well raised above the level of the agar. Individual colonies are smooth, round, of

uniform homogeneity with an even contour. Each colony has a convex surface elevation, and in profile is quite lenticular in appearance. During the first ninety-six hours of incubation the colonies have a striking iridescence, but there is no diffuse of any pigment into the agar itself. In order cultures this phenomenon is absent. In size the colonies are .75 mm., and active growth does not occur after thirty-six to forty-eight hours. At first the growth is readily removed with the platinum loop, but as time passes it becomes very tenacious, dry and very difficult to lift off the agar. In very old cultures the growth becomes more and more transparent, and appears to cling close or adhere close to the medium. It then tends to come away in a skin or in stringy lumps, and is not easily spread on solid media when subculturing. The water of condensation is milky white in colour.

Agar stab.—Good growth all the way down the needle tract, but best developed under the surface of the agar. No gas. Colonies are typical. The surface of the agar is covered between the forty-eighth and seventy-second hour.

Glycerine agar.—Colonies are physically similar to those in ordinary agar, but growth is neither so profuse nor so rapid. Iridescence present, but disappears between seventy-second and ninety-six hour. Water of condensation less milky.

Glucose agar.—Physically the colonies are somewhat larger than on the two preceding media, but growth is slower, less luxuriant, and mostly in evidence near the water of condensation. Iridescence present and lasts for about ninety-six hours. In glucose agar stab there is no iridescence, and very poor growth at point of stab. Along the needle tract, however, there is fair growth, which is filiform or cylindrical in shape. No gas formation.

Liver infusion agar.—The growth is quite good and similar to what is observed on ordinary sugar, but the iridescence is not apparent. It has a nacreous bluish appearance, while the edge of the culture is erose.

Ox serum agar.—Growth is very similar to what occurs on plain agar, but the iridescence is not so evident, though it persists for ninety-six hours. It is best seen along the edge of the growth and near the water of condensation. In old cultures the growth dries rapidly into a tenacious skin which is very difficult to remove or even to see, as it is of the same colour as the medium itself. Many colonies are larger than what is seen on ordinary agar, but physically they do not differ.

Sheep blood (defibrinated) agar.—No iridescence was ever recorded. On the whole, however, the growth is similar to that found on plain agar, i.e. it is nacreous in appearance with a bluish tinge. Older cultures are very tenacious, and grow best near water of condensation, where they appear creamy and may take on a greenish colour. About the individual colonies no haemolysis was observed.

Chocolate agar.—No iridescence present. Very shiny and transparent except near water of condensation, where it is thicker and more creamy. Physically, however, the colonies resemble those found on plain agar.

Inspissated bovine serum.—Growth is very poor and iridescence is absent. Individual colonies resemble those found on ordinary agar, except that they are much smaller. There is no digestion of the medium.

Gelatin: (a) Stab culture.—No liquefaction. Colonies are very small, and only present at site of stab and immediately under the surface of the medium. In older cultures (i.e. after ninety-six hours' incubation) a few minute colonies appear in the depth of the medium along the stab.

(b) Slope culture.—Very scanty growth. Only three or so minute dew-drop colonies observed. No liquefaction.

No growth was obtained on lead acetate agar, MacConkey's medium, ordinary potato, glycerine potato, etc.

Note.—The foregoing observations were made on media incubated at 37° C. Certain cultures were, however, sown with material and kept at room temperature (i.e. 20° C.), and it was found that although growth was very slow in its initial stages it soon speeded up, so that within a week of seeding there was no appreciable difference between the luxuriance of cultures incubated at room and body temperature.

Biochemical Characters.

(a) The organism does not form indol and fails to reduce nitrates. Although an iridescence was noted in young agar cultures, no pigment was formed which could be isolated. Further, the agar medium itself did not become discoloured, and as noted above the iridescence disappeared after four days' incubation.

(b) The carbohydrate fermentation reactions were fairly regular. No gas was ever produced, but acid was formed constantly in saccharose, mannite and sorbite.

Variable results were obtained with dextrose and xylose. In the following table sugar reactions with different strains are set down, namely :—

			Strain from Aberdares	Freshly isolated strain from Kipkabus	Strain 3011 (old strain)	Strain 3011 exhalted by passage per Sheep 3242
Dextrose	..	..	+	—	+	+
Lactose	..	..	—	—	—	—
Saccharose	..	..	+	+	+	+
Mannite	..	..	+	+	+	+
Dulcite	..	..	—	—	—	—
Maltose	..	..	—	—	—	—
Arabinose	..	..	—	—	—	—
Dextrin	..	..	—	—	—	—
Raffinose	..	..	—	—	—	—
Rhamnose	..	..	—	—	—	—
Salicin	..	..	—	—	—	—
Sorbite	..	..	+	+	+	+
Xylose	..	..	—	—	—	+
Inosite	..	..	—	—	—	—

The carbohydrate reactions are of no value in arriving at the true bacteriological position of the organism.

Resistance.

The organism soon loses its virulence under artificial conditions, and tends to die out rapidly if not subcultured every four or five days. It is rapidly destroyed by .5 per cent phenol or formalin, by boiling, dessication or direct exposure to sunlight. Even broth cultures kept at room temperature in a dark cupboard die in twenty-one days or so. In one observation eight hours of continual sunshine completely sterilised a broth culture. During the preparation of vaccine, it was found that .5 per cent formalin killed the organism in about six hours.

In the animal body the organism may not be found in chronic or old pneumonic lesions.

Animal Inoculations.

The organism is pathogenic for guinea-pigs, rabbits, goats, sheep and cattle; pigeons are very resistant.

(a) Guinea-pigs succumb to intraperitoneal, intrathoracic and subcutaneous inoculation of the organism. In the first two cases there is a little purulent exudate formed in the serous cavities, while the lungs are deeply congested. When given subcutaneously there is pulmonary congestion and necrosis at the site of inoculation. The organism is easily recovered from the heart blood and purulent material. In male animals intraperitoneal injection does not cause an orchitis.

(b) Rabbits die within thirty-six hours, following intravenous inoculation of small doses of culture, from acute congestion of the lungs. They are more resistant to the subcutaneous method, living up to thirty days after inoculation of as much as 3 c.c. culture. In fatal cases there is necrosis at the site of inoculation, pulmonary congestion and often subacute gastro-enteritis. Squirting 2 c.c. broth culture into the nasal chambers caused death in two animals in seventeen days or so, but the post-mortems were negative. Rabbits, while susceptible to the organism, possess more resistance than guinea-pigs.

(c) Goats are susceptible to the disease both in the field and under laboratory conditions. They readily succumb to intrathoracic, intravenous and subcutaneous injections of virulent cultures.

(d) Cattle are far more resistant than goats, and in them the organism exerts a necrotic action. Bovine 2831 died from a localised necrotic pneumonia with overlying fibrinous pleurisy fifteen days after 5 c.c. culture had been inoculated intrathoracically, while Bovine 2824 died twelve days after inoculation of 15 c.c. culture given subcutaneously over the loins. In the latter case there was a very marked necrotic myositis and infiltration of the subcutaneous tissues at the site of the needle puncture. In both animals the pathological lesion produced was quite distinct from the typical Laikipia lesion of sheep and goats. Two other cattle (Nos. 2828 and 2152) survived intravenous and intrapulmonary inoculation of 5 c.c. culture in both cases respectively.

Toxin Formation.

No toxin is formed at any period of growth on culture. Sheep inoculated intrapulmonary with filtrate of cultures passed through a Seitz No. 6 or the usual Berkefeld candle, gave no reaction, and on autopsy showed their lungs to be perfectly normal.

Many experimental animals, including one bovine which died after intrapulmonary inoculation of a culture, showed a more or less generalised icteric condition of the viscera similar to what Carre¹⁷ has observed in some cases of caseous suppuration of sheep, and which he regards as due to the toxin of the Preisz-Nocard organism. No explanation of this jaundiced condition was ever found, but it apparently cannot be regarded as due to a toxin of the *Laikipia* organism.

ROLE OF OTHER BACTERIA IN THE PATHOGENESIS OF
LAIKIPIA LUNG DISEASE.

In the introduction to the part dealing with the etiology of *Laikipia* lung disease, mention was made of the constant presence of certain organisms in the lung and joint lesions, some of which might possibly play a secondary role in the pathogenesis of the disease. Of these organisms it was soon found that the most important was a gram-positive diplo-streptococcus which was pathogenic for lambs when given intrapulmonary or intravenously.

Cultural Characters and Morphology of Sheep Diplo-streptococcus.

The organism is gram-positive, non-motile, and, as its name suggests, occurs as diplococci or short-chained streptococci. In the latter case the chain is composed of paired diplococci.

On blood agar plates, after 120 hours' incubation, a faint naemolytic zone appears around the colonies. This becomes more marked in older cultures.

On culture media the growth is characteristic of a streptococcus, i.e. on solid media the colonies are very small, like dew-drops, more raised in the centre than at the periphery, and with even contour. Growth is extremely poor on inspissated serum, but on blood agar the colonies appear bluish; they are the size of a pin-head, and have a convex contour in profile. Older colonies are cream in colour and appear like a minute head of pus. Blood agar is the best medium for growth of this organism.

In liquid media there is uniform turbidity, but no pellicle. There is always a more or less considerable lump deposit, especially in dextrose bouillon; least of all in ordinary or serum bouillon.

Smears from various cultures show that the organism may be a single coccus or present in pairs as diplococci, or forming short chains as a result of the diplococci being arranged end-to-end, thus resembling a streptococcus. These chains may be composed of pairs varying in number from 2, 4, 6, giving a total count of 4, 8, 12 cocci.

Each coccus averages .5 micron in diameter, so that a chain may measure up to 5 microns to 6 microns in length, but the average is two or three pair of cocci. On blood agar the diplococcoid forms greatly predominate, while the chains are best seen in liquid media. Each organism appears to be more lance-shaped than coccoid.

As regards the carbohydrate reactions, no gas but acid is produced in mannite, dextrin, raffinose, and salicin.

Animal Experiments with the Diplo-streptococci.

The organism is undoubtedly a saphrophyte of the lower respiratory tract in normal sheep, for it was frequently isolated in association with the Laikipia organism from cases which succumbed after intrapulmonary inoculation of pure cultures of the specific organism.

Sheep were the only animals affected and as a result of inoculation experiments the conclusion was reached that the diplo-streptococcus was often responsible for the pyogenic lesions in Laikipia lung disease, the specific organism damaging the lung by producing a broncho-pneumonia in which the coccus found a favourable medium for active proliferation and formation of abscesses. From this statement it must not be deduced that the specific organism itself cannot produce pyogenic lesions, for in a high percentage of cases it is found in pulmonary abscesses unassociated with the diplo-streptococcus, or in conjunction with other bacteria.

Observations on Other Bacteria found in Lesions of Laikipia Lung Disease.

Of the other bacteria generally found in the thoracic or joint lesions of lung disease, the most interesting was *B. Bronchisepticus ovis*, an ordinary and common saphrophyte of the respiratory tract of healthy sheep. This organism is nearly always absent from the normal sheep lung, but it may

be obtained from their main and smaller bronchi and trachea. When present in the lung it is always associated with some pathologic foci, and there is a frequent invader of the pneumonic or pyogenic lesions of Laikipia lung disease. On culture it is very similar to the Laikipia organism, though on agar media, it lacks on young cultures, the characteristic iridescence. It is quite non-pathogenic for sheep. Our strain produced no gas but traces of acid in dextrose, saccharose, mannite, maltose, dextrin and sorbite. Its differentiating feature therefore from the Laikipia organism, according to the sugar tests, is its ability to produce acid in maltose and dextrin.

The bronchi-septicus group of micro-organisms are now regarded as being inert as primary infective agents, but under certain conditions, especially when the body is the subject of an infectious disease, they may assume slightly pathogenic power and become capable of causing pathological lesions. For instance, in canine distemper, which is now finally known to be due to a filtrable virus, the respiratory lesions are probably due to the attack of saphrophytes in the lower bronchial tree on the lungs, whose resistance is lowered by the virus circulating in the blood. In the present investigation, the organism known as the bacillus bronchisepticus ovis has never been shown to possess any pathogenic power whatsoever.

Elimination of a Filter-passing Virus as the Primary Etiological Agent.

Several farmers held that Laikipia lung disease was merely a particularly peracute form of sheep-pox, complicated by advanced thoracic lesions. Whitworth⁵ dispelled this view and showed that the lung disease was observed in parts of the country where sheep-pox was unknown, and that animals which recovered from the lung disease were very susceptible to pox. Finally, he was unable to prove the existence of any virus in sick lambs.

These observations have recently been confirmed on many occasions. No virus can be demonstrated in either the blood of acute cases of the disease or in the pulmonary tissues.

It may therefore be accepted that the disease is not due to a filtrable virus.

Tables are submitted comparing the Laikipia bacillus and the diplo-streptococcus with some other bacteria described in the literature which are capable of causing pyogenic lesions in sheep. A comparison of their carbohydrates is also shown.

LAIKIPIA LUNG DISEASE
FERMENTATION REACTIONS OF SOME BACTERIA
PATHOGENIC FOR SHEEP.

Sugar	Sprays diplococcus	Bac. Purificans (Christiansen)	Hemophilis ovis (Mitchell)	Pasteurella ovis (Magnusson)	Laikipia organism	Diplo- streptococcus (Laikipia)	Bac. pyogenes (Magnusson)	Bacillus of Preisz-Nocard (Spray)
Fructose ..	+	+	+	+	N.T.	N.T.	+	+
Jalactose ..	+	+	+	+	N.T.	N.T.	+	+
Glucose ..	+	+	+	+	+	—	+	+
Mannose ..	N.T.	+	+	+	N.T.	N.T.	+	N.T.
Arabinose ..	—	—	—	—	—	—	—	—
Xylose ..	+	+	+	—	—	—	+	—
Rhamnose ..	N.T.	—	—	—	—	—	—	N.T.
Lactose ..	+	+	+	—	—	—	+	—
Maltose ..	+	+	+	—	—	—	+	—
Saccharose ..	+	+	+	+	+	—	+	—
Raffinose ..	N.T.	—	+	—	—	+	—	N.T.
Amyl. Sol ..	N.T.	—	N.T.	N.T.	N.T.	N.T.	—	N.T.
Inulin ..	—	—	—	N.T.	—	—	—	—
Salicin ..	—	—	—	N.T.	—	+	—	—
Glycerol ..	—	—	N.T.	—	N.T.	N.T.	—	—
Erytrol ..	N.T.	—	N.T.	—	N.T.	N.T.	—	N.T.
Acetonite ..	N.T.	—	N.T.	—	N.T.	N.T.	+	N.T.
Dulcitol ..	N.T.	—	N.T.	—	—	—	—	N.T.
Mannitol ..	—	+	—	+	+	+	—	—
Sorbital ..	—	—	+	+	+	—	—	—
Inosite ..	—	—	—	—	—	—	N.T.	—

+ = Acid but not gas.

— = Negative.

N.T. = Not tested.

(After Magnusson 12 with additions).

TRANSMISSION AND PATHOGENESIS.

Transmission of the Disease under Natural Conditions.

This subject has already been discussed at length under the heading "Epizootiology," but it will be remembered that it is not known how healthy lambs contract the disease. Possibly infection usually occurs either through the alimentary canal or through the air passages.

In new-born lambs, especially when a serious mortality occurs soon after birth, navel infection cannot be entirely dismissed, but in the post-mortems that have been made during this investigation the umbilical vessels were always free from pathological changes. Judging from the histories of new outbreaks, it would seem as if actual contacts of susceptible sheep with chronic lungers may suffice, but here again such animals may infect bomas, etc., so that infection is quite likely to occur *per os*. Undoubtedly sick animals discharge the organism from their bodies in immense numbers,

so that the grazing, etc., must sooner or later become heavily contaminated with the organism. Ewes, which are chronic lungers, do not excrete the organisms in their milk.

The rapidity with which the organism tends to die out under artificial conditions or be destroyed by sunlight, and its slow propagation at ordinary temperature, show that the disease is probably maintained in a flock by chronic lungers, and that infection must be more or less direct.

As the organism is evidently of low pathogenicity, the importance of predisposing agents in reducing the resistance of lambs or increasing their susceptibility cannot be minimised and in the prophylaxis of the disease measures should be adopted to avoid such contingencies.

This aspect of the disease will be further discussed under prophylaxis. The freedom of the lymphatic system from lesions caused by this bacillus does not point to infection occurring through subcutaneous routes, and Whitworth's opinion that seeds, grasses, etc., may inoculate the organism has not been confirmed. In two other sheep diseases, e.g. caseous suppuration in Australia and the pyogenic condition described in Scandinavia by Magnusson and Christiansen, it has been suggested that the specific organism is injected by some botanic agent, in the latter condition, for instance, by the spiny plant *Hippophae rhamnoides* (family, *Rhamnaceae*). There are certain numerous plant agencies in Kenya which are quite capable of introducing bacteria under the skin of sheep or of any other animal, but no foreign bodies have ever been observed to play any role in the pathogenesis of this disease.

Artificial Transmission.

Unless strains freshly isolated are employed, failure will attend all transmission experiments. The two requirements for successful experimental results are young or new-born lambs, obtained from a "clean" area, and recently isolated strains of the micro-organism.

Experimentally, the organism has been inoculated into lambs by the following channels, viz.: intravenous, subcutaneous, intratracheal, intrabronchial, intrapulmonary, intrapleural, intraumbilical, etc., and cultures have been painted on the cornea, injected up the anterior nares, and inoculated into the tongue or buccal mucosa. Drenching of cultures or purulent material was frequently practised, while in lactating ewes intramammary inoculations were conducted to determine if the organism excreted in the milk is capable of setting up pathogenic lesions in sucking lambs.

LAIKIPIA LUNG DISEASE

	Laikipia Bacillus	Diplostreptococcus associated with Laikipia organism	Bacillus purificans (Christiansen).	Bacillus of caseous sup- puration in sheep	B. pyogenes (Descazeaux)	Di- of
Staining and Morphology.	Gram neg. Pleomorphic, non-motile.	Gram positive Diplococcoid or Streptococcoid non-motile	Gram negative bacillary, non-motile.	Gram positive Pleomorphic, non-motile.	Gram positive Pleomorphic, non-motile.	Gram Ple no
Plain Agar.	Good growth. Colonies are iridescent.	Growth is fair, but colonies are very small.	Abundant growth.	Good growth. white brittle colonies.	Growth is very scanty.	No
Serum Agar.	Abundant growth.	Colonies are small.	Abundant growth.	Abundant, dry and yellowish.	Colonies are very small.	Colo
Blood Agar.	Abundant growth, no hæmolysis.	Good growth, slight hæmolysis.	Abundant growth, no hæmolysis.	Colonies are 5 mm. in diam. abundant, no hæmolysis.		Small -5 d
Gelatin.	Scanty growth, no liquefaction.	No liquefaction.	Scanty growth, no liquefaction.	No liquefaction.		Liq
Milk.	No change.		No change.	No change.	Coagulum rapidly peptonised.	Clot pe
Loefflers serum.	Numerous small colonies. No liquefaction.	Poor growth. No liquefaction.	Abundant growth. No liquefaction.	Numerous colonies. No liquefaction.	Numerous colonies. Liquefaction.	A g Liq
Broth.	Turbid, pellicle, slimy rosey deposit.	Turbid, no pellicle, no deposit.	Turbid.	Turbid, pellicle, granular deposit.	Very poor growth.	No
Sugar reactions Lactose, Xylose, Maltose, Saccharose.	No gas. Acid in Saccharose, rarely in Xylose.	No gas. No acid.	No gas. Acid.	No gas. No acid.	No gas. No acid.	No
Pathogenicity for guinea pigs.	Fatal producing pyogenic lesions.	No changes.	No changes.	Causes a fatal orchitis.	Fatal for guinea pigs.	Fat ne
Reference.			Jl. Comp. Path. and Therap. Jan. 1929.	Classical descriptions in text-books.	Rev. Gen. de Med. Vet. 1928, 37, 153.	Jl. 1923

NAIROBI SHEEP DISEASE.

By R. Daubney.

It has been suggested that this disease, which was recorded by Montgomery, 1913 to 1917, is identical with Heartwater. Towards the end of the year efforts were made to obtain cases of Nairobi Sheep Disease in order to compare it with the strain of Heartwater that was being maintained at the Laboratory, and if necessary to carry out cross-immunity tests between the two diseases.

Although our efforts were for a time unsuccessful, two outbreaks of Nairobi Sheep Disease were eventually discovered in the Kikuyu Reserve not far from the Laboratory. Experiments in progress at present appear largely to confirm Montgomery's findings, and although a report will not be available for some time it can be stated at once that the disease is quite distinct from Heartwater, and that it is transmitted by the brown tick *Rhipicephalus appendiculatus*, the common vector of East Coast Fever.

ABSCESSSES IN THE BRAIN OF SHEEP.

By R. Daubney.

A small outbreak of disease occurred on a farm in the Nanyuki area, in which animals were observed to die with symptoms of nervous derangement (usually paraplegia) within a period of a few hours after having first been noticed as ill. On one farm more than seventy animals died showing similar symptoms within a period of two or three weeks; and it was remarked that the majority of the deaths occurred in two or three flocks; the remaining flocks furnishing no cases of the disease at all. We were fortunate in being able to carry out two post-mortem examinations on typical cases of the disease; in both cases there was an abscess at the base of the brain in the Pituitary fossa, involving both the anterior and posterior portions of the pituitary. A third case, the brain of which was despatched to the Laboratory in formalin, showed a similar abscess in the olfactory lobe. In all cases the pus was similar to that seen in Preisz-Nocard infections of sheep, and diphtheroids could be demonstrated in sections of the affected tissues. It would be of interest to obtain cultures of the organism should further cases of the disease arise, and to determine its identity.

EAST AFRICAN SWINE FEVER.

By J. Walker.

Experiments in connection with the (1) prophylactic vaccination with spleen extract and blood respectively, (2) preparation of anti-serum, and (3) immunisation by the serum simultaneous method, were continued.

(1) *Prophylactic Vaccination.*(A) *Inactivated formalised spleen extract.*

Previous experiments showed that inactivated extract conferred little or no immunity. A small percentage of pigs thus treated did survive an immunity test, but some of the non-vaccinated (controls) also survived inoculation with the same virus.

In 1929 and 1930 a further lot of susceptible pigs were vaccinated with *inactivated* spleen extract prepared as follows, viz.: The spleens of three pigs, Nos. 1286, 1287 and 1288, reacting to blood in O.C.G. ex pig 1282 of the 15/4/29, were collected on the fourth day of the temperature reaction, viz. the 26/12/29; minced in a Latapie; the mince pooled and mixed with normal saline in the proportion of one of mince to four of saline, the mixture then well shaken with glass beads, stored overnight at 1° C. and the following morning filtered through muslin and the filtrate treated with varying strengths of commercial formalin (38.1 per cent Formaldehyde). In some instances the formalised pulp was added with Toluol 1 per cent; the extract was then stored in the ice chest at 1° C. and on the thirteenth and twenty-fourth days after the date of preparation utilised to inoculate some susceptible pigs which weighed from 60-70 lb. with the exception of one, viz. 1230, which weighed 140 lb.

(B) *Inactivated citrated blood.*

Some blood was collected at time of slaughter from the pigs which furnished the spleens. It was bled into equal parts of citrate solution on the 26/12/29, and treated with commercial formalin (38.1 per cent Formaldehyde) in the proportion of 1 of commercial formalin to 500 of blood and Toluol then added to make 1 per cent of the total bulk. The thus treated blood was kept at 1° C. and used twenty-four days later for an experimental inoculation.

The experimental inoculations with the inactivated spleen and blood respectively, and results are shown in Table No. 1.

TABLE NO. 1.—(EAST AFRICAN SWINE FEVER)
EXPERIMENTAL INOCULATIONS WITH INACTIVATED SPLEEN EXTRACT AND BLOOD RESPECTIVELY EX PIGS
1286, 1287 AND 1288—26-11-1929.

No. of Pig	Strength of Commercial Formalin (38.1% Formaldehyde) and Toluol 1%	Dates of Inoculation	Dose	Result	IMMUNITY TESTS.					Result
					Date	Virus	Result	Retest on immunity date	Virus	
1274	1-100 formalised spleen.	20-12-29 28-12-29 4-1-30	25 c.c. = 5 grms.	No reaction	21-1-30	1 c.c. spleen + Toluol 1% ex 1282 of 15-10-29.	Pig missing from 29-1-30.	—	—	—
1277	1-250 formalised spleen.	20-12-29 28-12-29 4-1-30	"	"	"	"	No reaction.	24-2-30	1 c.c. blood in O.C.G. ex 1254 of 21-1-30.	Reacted and recovered.
1280	1-250 formalised spleen + Toluol 1%	20-12-29 28-12-29 4-1-30	"	"	"	"	"	"	"	"
1230	1-300 formalised spleen.	9-12-29 16-12-29 23-12-29 28-12-29 4-1-30	"	"	13-1-30	"	Reacted and died of swine fever.	—	—	—
1269	1-750 formalised spleen + Toluol 1%	20-12-29 28-12-29 4-1-30	"	"	21-1-30	"	No reaction.	10-2-30	1 c.c. blood in O.C.G. ex 1254 of 29-1-30.	Reacted and died.
1273	1-800 formalised spleen.	20-12-29 28-12-29 4-1-30	"	"	"	"	"	"	"	Reacted and recovered.
1275	1-1000 formalised spleen.	20-12-29 28-12-29 4-1-30	"	"	"	"	Reacted to swine fever from the 5th and recovered.	"	"	"
1241	1-500 formalised blood + Toluol 1%	20-12-29 28-12-29 4-1-30	"	"	"	"	No reaction.	"	"	"

Summary.

1. Spleen pulp treated with varying strengths of commercial formalin, viz. 1/1000 to 1/100 and in some instances additioned with Toluol 1 per cent, was inactivate on the thirteenth and twenty-fourth days after storage at 1° C. Of the pigs inoculated with the inactivated extract 66 per cent did not react to Swine Fever when tested on their immunity to a virus which was active but in process of attenuation; 33 per cent reacted to Swine Fever, of which 50 per cent died. The non-reactors to the immunity test, when retested on their immunity to a more active virus, reacted with some mortality.

2. Formalised blood 1/500 additioned with Toluol 1 per cent and stored for twenty-four days was also inactivate and did not produce Swine Fever.

The pig in experiment, viz. 1241, did not react when tested on its immunity with a virus in process of attenuation. When retested on its immunity with a more active virus it reacted and recovered.

(C) *Non-inactivated but attenuated formalised spleen extract*

The possibility of successfully actively immunising susceptible pigs with spleen extract attenuated by formalin, was investigated.

A portion of the spleens of pigs 1286, 1287 and 1288, after treatment as described above, was stored for forty-eight hours at 1° C. and then used for experimental inoculations.

(D) *Non-inactivated ? formalised citrated blood.*

Blood ex pigs 1286, 1287 and 1288 was collected on the 26/11/29 and after treatment as described above, stored for seventy-two hours at 1° C. and inoculated to a susceptible pig.

The experimental inoculations with non-inactivated attenuated formalised spleen extract and formalised blood are shown in Table N.o 2.

TABLE NO. 2.—EAST AFRICAN SWINE FEVER.
EXPERIMENTAL INOCULATIONS WITH FORMALISED SPLEEN EXTRACT AND BLOOD RESPECTIVELY EX PIGS
1286, 1287 AND 1288—26-11-1929.

No. of Pig	Strength of Commercial Formalin (38-1% Formaldehyde) and Toluol	Dates of Inoculation	Dose	Result	Remarks	IMMUNITY TESTS					Result
						Date	Virus	Result	Retest on Immunity Date	Virus	Result
1261	1-100 formalised spleen.	28-11-29 6-12-29 16-12-29	25 c.c. " "	Doubtful temperature reaction from the 16th to 23rd day. Max. temp. 103.6°F. 18-12-29. Reacted from the 15th to 42nd day.	Blood of 1261 19-12-29 did not produce Swine Fever. Blood of 1262 19-12-29 produced Swine Fever.	6-1-30 6-1-30	Blood of O.C.G. ex 1282 of the 15-10-29. ditto	Reacted and re-covered. No reaction.	..	—	—
1262	1-250 formalised spleen.	28-11-29 6-12-29	" "	Temperature reaction? Maximum 103.4°F. 14-12-29.	Blood of 1255 19-12-29 did not produce Swine Fever.	7-1-30	1 c.c. spleen + Toluol 1% ex 1282 of the 15-10-29.	"	24-2-30	Blood of O.C.G. ex 1254 of the 29-1-30.	Reacted and re-covered.
1263	1-500 formalised spleen.	28-11-29 6-12-29 16-12-29	" " "	Reacted to Swine Fever and recovered.	—	31-12-29	5 c.c. blood in O.C.G. ex 1282 of the 15-10-29.	"	—	—	—
1266	1-750 formalised spleen + Toluol 1%	28-11-29	"	Reacted to Swine Fever from the 5th to 11th day.	—	31-12-29	1 c.c. blood ex 1282 of the 15-10-29.	"	—	—	—
1265	1-800 formalised spleen.	28-11-29	"	Reacted to Swine Fever from the 3rd to 10th day.	Blood of 1265 21-12-29 produced Swine Fever and death.	31-12-29	2½ c.c. blood ex 1282 of the 15-10-29.	"	—	—	—
1259	1-1000 formalised spleen.	28-11-29	"	Reacted from the 3rd day and killed for virus.	—	7-1-30	1 c.c. spleen + Toluol 1% ex 1282 of 15-10-29	Reacted and re-covered.	—	—	—
1239	1-500 formalised blood + Toluol 1%	29-11-29 6-12-29 16-12-29	50 c.c. " "	Indefinite temperature reaction. Max. 104°F. 14-12-29.	Blood of 1239 of 11-12-29 did not produce Swine Fever.	7-1-30	1 c.c. spleen + Toluol 1% ex 1282 of 15-10-29	Reacted and re-covered.	—	—	—

Summary.

1. Spleen pulp plus saline treated with commercial formalin 1 in 1000, 1 in 800, 1 in 750 plus Toluol 1 per cent, 1 in 500 and in 250 of the extract was still active after storage for forty-eight hours at 1° C.

The pig inoculated with the 1/1000 formalised extract was destroyed for virus for hyperimmunising purposes; the four others treated with the above mentioned formalised extract reacted to Swine Fever and recovered, and when tested on their immunity with an active virus proved resistant.

2. The spleen pulp treated with formalin in the proportion of 1 of formalin to 250 of spleen plus saline, and additioned with Toluol 1 per cent, produced an *indefinite* temperature reaction. When tested on its immunity with a virus in process of attenuation pig 1255 did not react; when retested on its immunity with a more active virus it reacted and recovered.

3. The spleen pulp plus saline treated with formalin, in the proportion of 1 of formalin to 100 of spleen extract, produced a *doubtful* temperature reaction (blood collected during the period of the doubtful reaction did not transmit Swine Fever or confer immunity). When tested on its immunity with a virus in process of attenuation, pig No. 1261 reacted and recovered.

4. The virulent blood treated with formalin 1/500 plus Toluol 1 per cent produced an indefinite temperature reaction (blood collected during the indefinite reaction did not transmit Swine Fever or confer immunity to a virus in process of attenuation). Pig 1239 reacted and recovered when tested on its immunity with virus in process of attenuation.

Controls for the virulency of the spleen pulp used for the prophylactic vaccination experiments and for the viruses utilised for immunity tests of vaccinated pigs.

The virulency of the spleen pulp was determined, prior to treatment, by inoculation of susceptible pigs with high dilutions.

The virulency of the viruses used for testing vaccinated pigs on their immunity was also tested by inoculation of susceptible pigs.

The details and results are shown in Table No. 3.

TABLE No. 3—EAST AFRICAN SWINE FEVER,
CONTROLS FOR THE VIRUSES.

Virus Tested on its Virulency	Date of Test	No. of pig put in Test	Result	Immunity Test		Result
				Date	Virus	
Blood in O.C.G. ex pig 1282 of the 15-10-29	20-11-29	1286, 1287, 1288	Reacted and destroyed for spleen.			
Spleen pulp of 1286, 1287 and 1288 of the 26-11-29—1-10-000 in saline	27-11-29	1272 }	Reacted and died of Swine Fever.			
1-25,000 in saline	27-11-29	1257 }				
Spleen pulp ex 1282 in saline + Toluol 1% of the 15-10-29	31-12-29	1281	Reacted severely and recovered.			
	21-1-30	1260	No reaction.	17-2-30	Contact infection.	Reacted.
	31-1-30	1278	No reaction.	24-2-30	Blood ex 1254 of the 29-1-30.	Reacted and recovered.
Blood in O.C.G. of 1254 of the 29-1-30 (Strain 1282)	19-2-30	1283	Reacted and died. ditto.			
Ditto	25-2-30	1300				

Summary.

1. The spleen pulp used for the experimental vaccinations was of high virulence prior to being treated.

2. The spleen pulp collected from 1282 on the 15/10/29 and treated with Toluol 1 per cent was active on the 31/12/29. On the 7/1/30 and 13/1/30 it transmitted and produced death (see Table No. 2). On the 21/1/30 it did not transmit or confer immunity in 100 per cent of susceptible pigs, six in test. (See Tables Nos. 1 and 3.)

3. Blood in O.C.G. ex 1254 of the 29/1/30 (1282 strain) was active on the 19/2/30 and 25/2/30.

(2) Preparation of Antiserum.

A number of recovered pigs were hyperimmunised and the serum tested on its potency after hyperimmunisation.

The method of hyperimmunising was as follows, viz.: Recovered pigs were injected intraperitoneally with virulent blood, at the rate of 5 c.c. per lb. body weight, collected from a reacting virus maker in 10 per cent of a 10 per cent solution of sodium citrate in distilled water. Fourteen days later the hyperimmunised pigs were bled from the carotid into bleeding jars and the blood stored for thirty-six hours at 5° C.

The serum which separated out from the clot was collected and after treatment with 0.5 per cent carbolic acid stored at 5 per cent.

*(3) Immunisation by (a) the serum simultaneous method, and
(b) serum alone and contact method.**(a) Serum simultaneous method.*

Susceptible pigs weighing from 45-67 lb. were injected subcutaneously with the pooled serum of hyperimmunised pigs and simultaneously with 1 c.c. of a mixture of equal parts of virulent blood and O.C.G. mixture. The doses of antiserum varied from 10 c.c. to 50 c.c.

(b) Serum alone and contact method.

A susceptible pig was injected subcutaneously with 20 c.c. of the pooled serum of hyperimmunised pigs and simultaneously put in contact with reacting pigs.

A susceptible pig was injected subcutaneously with 35 c.c. of pooled serum of hyperimmunised pigs and eight days later put in contact with reacting pigs.

The experiments and results are shown in Table No. 4.

TABLE NO. 4.—EAST AFRICAN SWINE FEVER IMMUNISATION.

(a) SERUM ALONE + CONTACT METHOD.

(b) SERUM SIMULTANEOUS METHOD.

No. of Pig Inoc.	Weight	Dose of Anti-serum, + virus subcutaneously	Date Inoculated	Result	IMMUNITY TESTS		
					Method	Date	Result
1308	52	(a) SERUM SIMULTANEOUS METHOD— 50 c.c. + 1 c.c. Blood in O.C.G. ex pig 1254 of the 29-1-30. 35 c.c. + 1 c.c. Blood in O.C.G. ex pig 1254 of the 29-1-30. 30 c.c. + 1 c.c. Blood in O.C.G. ex pig 1254 of the 29-1-30. 30 c.c. + 1 c.c. Blood in O.C.G. ex pig 1254 of the 29-1-30. 25 c.c. + 1 c.c. Blood in O.C.G. ex pig 1254 of the 29-1-30. 20 c.c. + 1 c.c. Blood in O.C.G. ex pig 1254 of the 29-1-30.	3-3-30	Temperature reaction from 4th to 6th day. Max. 105.6°F. Recovered.	—	—	
1305	65		25-2-30	Temperature reaction from 4th to 6th day Max. 104.6°F. Recovered.	—	—	
1304	67		25-2-30	Temperature reaction from 4th to 6th day Max. 104.4°F. Recovered.	—	—	
1311	45		3-3-30	Temperature reaction from 3rd to 9th day. Max. 104.6°F. Recovered.	—	—	
1302	65		25-2-30	Temperature reaction from 4th to 7th day. Max. 106°F. Recovered.	—	—	
1303	67		25-2-30	Temperature reaction from 3rd to 5th day. Max. 105°F. Recovered.	—	—	
1306	60	15 c.c. + 1 c.c. Blood in O.C.G. ex pig 1254 of the 29-1-30.	25-2-30	Temperature reaction from 4th to 6th day. Max. 105.4°F. Recovered.	Placed in contact with reacting pigs from the 10 c.c. fresh citrated blood ex pig 1283	6-3-30 No re-action.	
1310	52	10 c.c. + 1 c.c. Blood in O.C.G. ex pig 1254 of the 29-1-30.	25-2-30	Temperature reaction from 4th to 6th day. Max. 105°F. Recovered.	—	6-3-30 "	
1301	46	(b) SERUM ALONE + CONTACT METHOD. 35 c.c. on the 25-2-30. 20 c.c. on the 28-2-30.	Date of Contact 5-3-30	Temperature reaction from 3rd day of contact. Maximum 105°F. Temperature normal 5th day.	—	—	
1285	50		28-2-30	Temperature reaction from 5th day after contact 105.6°F. Temperature normal 9th day.	—	—	
1300	..	CONTROL FOR VIRUS— 1 c.c. blood in O.C.G. ex pig 1254 of the 29-1-30.	25-2-30	Temperature reaction from the 2nd day. Max. 106.6°F. Animal died of Swine Fever on the 5-3-30.	—	—	

Summary.

(a) *Serum simultaneous method.*—The pooled serum of hyperimmunised pigs protects susceptible pigs against a severe reaction and death to simultaneous inoculation of a dose of virulent blood (eight in experiment).

(b) *Serum and contact method.*—Doses of 35 and 20 c.c. respectively protected against a severe reaction to simultaneous, and eight days later, respectively, contact infection.

Conclusions.

1. Inactivated spleen pulp and blood respectively.

A. Virulent spleen pulp plus saline is inactive thirteen days, and probably sooner, after treatment with commercial formalin (38.1 per cent Formaldehyde), varying from 1/1000 to 1/100 of the total bulk, and storage at 1° C.

B. Inactivated formalinized spleen pulp plus saline (three injections at intervals of seven days) does not protect against a reaction with some mortality, to an attenuated virus, and to a non-attenuated virus. Total mortality=33 per cent.

C. Virulent citrated blood is inactivate seventy-two hours after treatment with commercial formalin so as to make 1/500 of the total bulk and additioned with Toluol so as to make 1/100 of the total bulk, and storage at 1° C.

D. Inactivated formalinized citrated blood (three injections at intervals of seven days) does not protect against a reaction to a non-attenuated virus inoculated thirty-seven days after the last dose.

(2) Non-inactivated but attenuated spleen pulp.

A. Virulent spleen pulp plus saline is attenuated after treatment with commercial formalin at 1/800, 1/750, 1/500 and 1/250 respectively, of the total bulk, and storage for forty-eight hours at 1° C. Pigs which react to inoculation of above-mentioned formalised pulp, are protected against a subsequent inoculation of a non-attenuated virus.

B. To attenuate spleen pulp plus saline to a degree of virulency which will produce in susceptible pigs a reaction with a negligible mortality and confer immunity against a non-attenuated virus, treatment with commercial formalin (38.1 per cent Formaldehyde) so as to make 1/500 of the total bulk would appear to be a suitable dilution, but further experimental inoculations are necessary to confirm this.

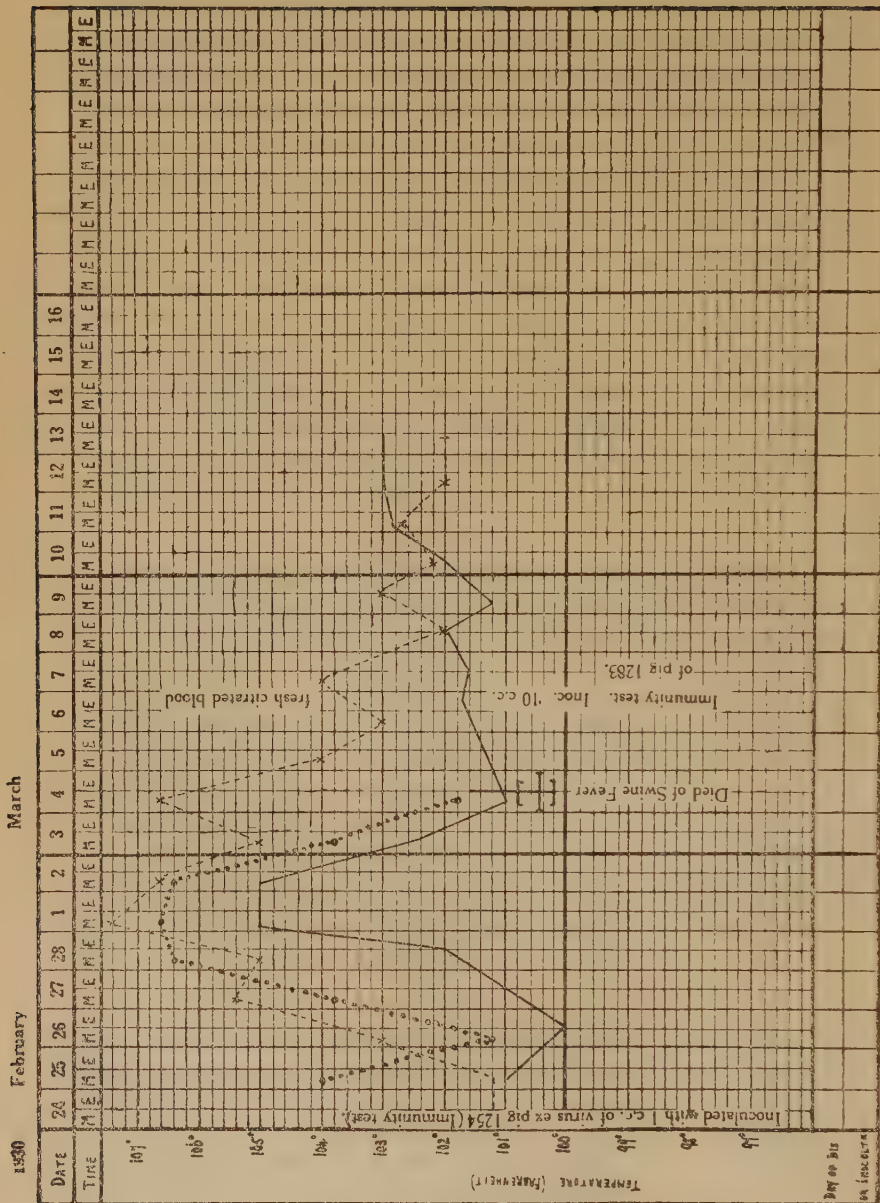
(3) The serum of hyperimmunised pigs protects, at a dose varying from 10 c.c. and upwards, against a severe reaction to simultaneous inoculation of a dose of virulent blood and contact infection respectively; an active immunity is conferred by the former method (serum simultaneous). Pigs which react to the serum alone and contact method are also actively immunised.

Discussion.

The experiments now recorded show that *inactivated* formalinized spleen pulp confers some resistance, but not sufficient to protect at the doses given against a reaction with a percentage of mortality to a dose of virulent blood. The number of experimental inoculations (2) with blood are insufficient to base a definite conclusion, but the indications are that some resistance is also conferred by inactivated formalinized blood.

Larger doses of inactivated formalised spleen, or blood, respectively, may confer a greater resistance, but taking into consideration the rapidity of the spread of the disease, prophylactic vaccination with *inactivated* spleen or blood respectively would not appear to be of assistance in combatting an outbreak. There is a possibility of conferring an active immunity with a negligible mortality by *non-inactivated* but *attenuated* by formalin, spleen pulp. Further lots of pulp should be treated to determine whether it is practicable to standardise and maintain the virulency at the desired degree of attenuation for pigs of varying susceptibility during the period which would elapse between date of preparation, completion of the virulency test, and the use of the treated pulp in the practice.

The serum simultaneous method or, serum alone and contact method has proved to be the more practical and safer method of conferring an active immunity and/or combatting outbreaks.



Temperature reactions of:
 (1) Control for the virus
 (2) Serum simultaneous
 inoculation
 (3) Immunity test of pig
 vaccinated with inacti-
 vated spleen pulp.

- (1) Control pig No. 1300 inoculated with 1 c.c. of virus ex 1254. 25/2/30.
 (2) ——— Pig 1310 inoculated with 10 c.c. antiserum + 1 c.c. of virus ex 1254. 25/2/30. Immunity test 6/3/30.
 (3) - - - - - Pig 1280 5 injections at 7 days interval of inactivated formalinized spleen pulp. Immunity test 24/2/30.

POISONOUS PLANTS OF KENYA.

PART I.

By R. W. M. Mettam.

Introduction.

The present investigation was undertaken with plants collected from the flora of the settled areas of the so-called "Kenya Highlands," by which term is meant that relatively small area of mountainous country, varying in altitude between 5,000 to 11,000 feet, forming a fertile oasis in a colony which is mainly of a semi-desert or tropical nature, quite unfit for European settlement and at present occupied by nomadic aboriginal tribes.

The flora of this alienated country varies considerably in character, but everywhere it is particularly rich in the more highly developed of the Dicotyledons, viz. Lamiales, Personales, Solanales, Asterales, etc. The nature of the flora is more temperate than tropical and readily contrasts with the rich luxuriance of Uganda or the Coastal belt which lie on the same latitude but at considerably lower altitudes.

The type of stock owned by the white settler varies from native to pedigree, with a fairly large percentage of grades. As may be expected the greatest loss from plant poisoning occurs in the high grade or pure breds, and it is often very annoying for a settler when his best animals, which have probably survived the many indigenous diseases, succumb to a poison in the grazing. It is not possible even to hazard a guess on the annual loss caused by poisonous plants in Kenya, but it must be considerable. To quote two instances, a dairy farmer in a few days lost twenty-five grade Ayrshire cows from Acokantherosis, while a cattle farmer near Molo lost forty-seven heifers in one night as result of poisoning by one of the Umbelliferae.

Extent of knowledge of Poisonous Plants in Kenya before 1927.

With the exception of an interesting paper by Stordy¹ on "arrow poison," no systematic attempt had been made prior to 1927 to collect information or data on poisonous plants in this Colony. It was generally agreed that severe losses occurred annually, but the menace of cattle plague and other major epizootics so thoroughly absorbed the attention of the veterinary staff that minor issues like plant poisoning had to be shelved for the time being. That the responsible authorities recognised the importance of the subject may be inferred

from the minutes of the 5th Pan-African Veterinary Conference² which was held in Nairobi in 1924. One delegate frankly said: "We know very little of the poisonous plants of East Africa." This statement was true not only as regards Kenya, Uganda and Tanganyika, but of the rest of Africa outside the Union.

Most farmers are naturally very interested in the subject, but in the past they have relied very closely on native testimony. On some occasions, however, they submitted specimens either to the Forestry Department or to the Mycologist, but generally these authorities, while able to identify the specimens, were quite unable to give any information on the supposed toxicity of the plant. It was also the custom to apply the knowledge gained in South Africa on different plants to the same or related species in this Colony, not always with satisfactory results, for even some of the plants proved toxic by Theiler and his co-workers in the Union have never been found poisonous in this Colony, e.g. *Tribulus terrestris*.

Value of Native Information on Poisonous Plants.

The Bantu native of tropical Africa possesses a very sound knowledge of poisonous plants. Most of the men pass their youth in herding cattle, sheep and goats, and they become ready observers of the virtues of the various non-graminaceous vegetation. Thus, the average Kikuyu herd, when the grass is low, allows his flocks to graze on certain plants which he knows are not only non-toxic but indeed valuable fodder plants. Possibly some of these on further experiment might prove valuable supplementary feeds for the stock of the settlers in times of drought. To quote a few instances, the leaves of *Ipomaea cardiosepala* (Convolvulaceae), *Glycine javanica* (Papilionaceae), *Helinus mystacinus* (Rhamnaceae), etc., are regarded by the Kikuyu as excellent fodder plants. It is also by experience that the herds recognise that grazing on such shrubs or trees as various species of *Acokanthera*, *Elaeodendron*, etc., will lead to certain death.

It is only natural that primitive races which may at certain times have to subsist on roots, etc., should possess a very sound knowledge of what is edible and what is not, even if the knowledge is vested in a few persons.

The value of native medicines requires thorough investigation for it must never be overlooked that chinchona bark "was originally a native Ecuador remedy" (Castellani).

Certain experiments, unfortunately there are but few, have been done at Kabete on some of the common Kikuyu remedies and it is hoped to devote a special paper to their description.

Thus, Daubney and the writer have investigated the virtue of the fruit of the shrub *Myrsine africana* (Myrsinaceae) as an anthelmintic, and the writer has experimented with the leaves of *Cassia didymobotyra* (Caesalpiniaceae) as a purgative and the roots of *Olinia usambarensis* (Oliniaceae) as a stomachic and gastric tonic. While on the subject of native medicines it may be mentioned in passing that the Masai regard a decoction of the leaves of the forementioned Cassia as a specific in the treatment of malaria, but no experiments have been done as far as the writer is aware, to determine the real value of this plant in the treatment of this disease.

It is admitted that native testimony is not always reliable, but it is always informative. Thus the Masai use the acrid juice of *Plumbago zeylanica* (Plumbaginaceae) as a curative for East Coast Fever, the juice being applied over the swollen glands. Local experiments have shown the treatment to be quite valueless.

Finally, as a point of interest, it may be stated that the tribes of East African native, with the possible exception of the Wakamba and the Coastal tribes, do not indulge in the ceremonies known as "trial by ordeal" to such an extent as do certain tribes of British Central Africa or of the Congo or of West Africa. Even where such ceremonies are held the dose of poison is so slight that the victim usually recovers, e.g. Bantu Kavirondo (Johnson).

The foregoing statement does not mean to imply that there are no deadly poisons used on human beings by the Bantu natives of East Africa. To the writer's certain knowledge the root of a species of *Adenia* (Modecca) was recently used in the Meru district by a native murder, whilst certain species of *Strophanthus* is a commonly used poisonous plant in the Coastal regions of Central Africa.

Conditions under which Plant Poisoning occurs in Kenya.

In a previous paper³ the writer has indicated the condition under which plant poisoning occurs in the Colony. Cases are mostly observed during the long dry period before the heavy rains, i.e. between December and April. However, no hard and fast statement can be made on the months when poisoning mainly occurs, as the rainy seasons vary in time and duration in different parts of the Colony. It may be accepted,

however, that animals must be very hard up for food before they begin to graze on extraneous vegetation, especially on those plants which contain latex or irritating juices, etc. In one outbreak investigated near Molo the season had been so dry that there was practically no grazing, and while searching for food the cattle wandered on to the dried-up bed of a river in the main part of the Mau forest. Although there was no green vegetation on the river bed the cattle in their eagerness for green food scraped away with their hoofs the dead growth, etc., and greedily fed on the roots and sprouting stems of a plant belonging to the family *Umbelliferae*, which the local farmer called "water parsnip," and which the local Masai and Lumbwa declared to be very poisonous.

At any rate nearly fifty cattle were found dead within twenty-four hours, some of them being unable to move out of the river bed itself.

By far the highest mortality occurs in pure-bred imported stock and in grades, and very often in animals moved from one part of the country to another where the nature of the grazing is strange and different. Native cattle appear to possess some inherent instinct on the relative values of non-graminaceous herbage as foods and it has been noticed that they will stand larger doses of poisonous material given experimentally than finer bred animals. The explanation of this observation is not clear, but it is as well to recall that many competent authorities believe that animals must acclimatise themselves not only to their new environmental and climatic surroundings but also to the new grazing conditions.

While most cases of plant poisoning have occurred in cattle, a severe outbreak of Acokantherosis was diagnosed among merino sheep on the Laikipia plateau during the present year, and cases of poisoning amongst swine have occurred near Timboroa following ingestion of the root of *Cissus erythrodes* (Ampelidaceae). In Nairobi poultry are not uncommonly poisoned by the drupes of the so-called Syringia (*Melia azedarach*—Mediaceae). So far no authentic case of plant poisoning amongst horses has yet been diagnosed, but a settler from the Naivasha district of the Rift Valley blames *Diplolophium abyssinicum*, or wild fennel (*Umbelliferae*), when fully grown and in the late flowering stage for causing deaths amongst his horses. No feeding tests have been made on horses with this plant, but inconclusive results were recorded when a sheep was drenched with a limited amount of

material. However, the Masai regard the plant as being very poisonous, but owing to the difficulty of obtaining sufficient fresh material no confirmatory feeding tests have yet been carried out.

The possibility of feeding a poisonous plant to stabled animals is a remote one in this Colony for two reasons, viz. (a) relatively few animals are kept indoors, and (b) cut grass is so seldom fed for fear of conveying ticks into the stable. Lucerne is a favourite stable food and in an outbreak of disease recently investigated amongst imported pedigree cattle the possibility of a poisonous plant included in the baled lucerne was considered as the cause.

Many farmers believe that wilted or wilting grass is a common source of poisoning in the Colony. Although there is no definite information on the point there is no reason why under suitable climatic conditions it should not occur. Most of the grasses used by Henrici⁴ in her experiments in Bechuanaland exist in East and Central Africa, while wilting of vegetation under a hot sun is only too common.

Several outbreaks of sickness for which no cause could be found showed typical symptoms of hydrocyanic acid poisoning set up by wilting grasses, etc., though no detailed observations could be made at the time. By the picrate test, however, most of the grasses in the Rift Valley and the settled areas may be shown to contain more or less large amounts of free hydrocyanic acid under favourable climatic conditions.

The malicious poisoning of settler stock by material of vegetable origin while it undoubtedly does occur, has never been definitely proved. Many settlers seek information on this question but obviously, until more is known about the poisonous plants of the country, and until reliable tests are discovered for detection of various poisonous principles, no definite replies can be given. Unlike the natives of the orient, the Bantu tribes were unfamiliar with mineral poisons before the advent of the Indian and European. Now-a-days the use of arsenic is well known to them and the habit is apparently, unfortunately increasing. Arsenic is obviously handy on most cattle farms in the country, as it appears to be essential for dipping operations.

The Diagnosis of Plant Poisoning in the Field of Kenya.

This is a subject of really great difficulty which requires the whole-time attention of a veterinarian with advanced botanical knowledge.

It is particularly on the chronic poisoning that the chief obstacles are encountered for it is now well known that symptoms of illness may only arise after a considerable amount of plant has been eaten or/and after a fairly definite "period of incubation."

The diagnosis of a chronic plant intoxication has not yet been made in Kenya, but there is no doubt that several obscure affections, which at present baffle solution, will be eventually traced to plant poisoning.

For instance, on several farms in the Nanyuki district there is a peculiar condition where the hoofs of cattle become deformed and cause the animal to walk with an awkward gait. In many respects the hoofs resemble those observed in South Africa in the disease "Styfsiekte" which, according to Burt Davy⁵ and Theiler⁶ is due to chronic poisoning by *Crotolaria burkeana* (Papilionaceae). There is no record of this particular species of *Crotolaria* being found in Kenya, though it has been identified in the Congo Belge and Tanganyika by van Saceghem and Cursom respectively.

There is in the Limuru district of Kenya (altitude 7,000 to 9,000 feet) on certain farms only, a peculiar disease of cattle in which there is an escape of blood from the injured mucosa of the bladder and the clinical appearance of an haematuria. For many years this condition was believed to be due to a poisonous plant, but no positive results ever attended feeding experiments. At the present time the plant theory has been abandoned in favour of some mineral deficiency in the pasturage, but the disease still remains obscure as regards its etiology.

The difficulty of elucidating certain conditions due to plants may be gathered from the prolonged investigation carried out by Theiler⁸ and⁹ and others on the South African sheep disease "geeldikkop" and "gousiekte" caused by *Tribulus terrestris* and *Vangueria pygnaea*, respectively.

For nearly a decade Theiler was completely baffled by these diseases and it was not until the co-operation of a botanist was obtained and the feeding of animals on definite areas systematically arranged that the real toxic agents were found. Similarly Andrews⁷, in his investigation on "pushing disease" in Natal was only able finally to inculcate a species of *Matricaria* after the tedious method of eliminating other plants.

In cases of acute plant poisoning there is often much positive or circumstantial evidence as to the real nature of the casual agent though, unfortunately, pathogonomic symptoms are very rare. In the majority of cases there is an acute gastro-enteritis with the passages of more or less profuse diarrhoea, but the presence of a concomitant fever often leads to confusion with one of the common infectious diseases, especially if many animals are simultaneously affected. The common infectious disease in Kenya which must be differentiated in cases of acute plant poisoning are: (1) Redwater, (2) Anthrax, (3) Heartwater, and (4) Rinderpest. The first and second may be easily excluded by direct blood examination, while in the third and fourth it is necessary to fall back on blood inoculations into susceptible animals or, in the case of Heartwater, by the discovery of *Rickettsia* in the endothelial cells of the kidney and brain.

It is often easy, however, to diagnose acute plant poisoning. The discovery of abnormal vegetable material of proved toxicity in the rumen is absolutely decisive, but even in certain cases it is impossible to find any foreign plant material, especially when only a little may have caused poisoning, e.g. certain of the *Liliaceae* and *Iridaceae*.

Again, the history that the animals have been grazing on herbaceous or shrubby vegetation, which they generally completely ignore, is an important diagnostic point, since it leads to examination of the plants and the possible recognition of proved poisonous species.

Should no poisonous plants, however, be found, it will be necessary to arrange a series of feeding experiments on the particular vegetation on which the animals had fed.

Requests have often been received from farmers in this Colony for information on the diagnosis of hydrocyanic acid poisoning caused by the ingestion of wilting grasses during certain seasons of the year. Many farmers believe that this form of poisoning is common in both cattle and sheep, and responsible for those cases of sudden deaths which occur without any apparent cause and in which there are no gross pathological lesions at post-mortem. The presence of hydrocyanic acid in plant material may be readily detected by the simple "vest-pocket test" first used by Armstrong and strongly recommended by Green and Andrews¹. Certain farmers have been instructed in the technique of this test, but at the time of writing very little information has been

received from them on their results. The writer, by means of the practical tests, has detected varying amounts of hydrocyanic acid in such grasses as *Themeda triandri*, *Aristida congesta*, *Cymbopogon excavatus*, etc., when they are wilting, in various parts of the Colony. No actual cases of hydrocyanic acid poisoning in the field have, however, ever been found.

Distribution of Poisonous Plants in Kenya.

No botanical survey has ever been made in Kenya. Indeed the flora of the country is not at all well understood, but it is satisfactory to know that the authorities at Kew have in course of preparation a detailed work dealing with flora of Eastern Tropical Africa.

At present it is quite impossible to give any indication of the distribution of poisonous plants in the country, but judging from climatic and other conditions, and the general types of flora found at different altitudes, it may be stated that the settled areas are not so abundant in poisonous plants as are the coastal region, the Kavirondo Plain and the great semi-arid regions.

During the past thirty months plants proved definitely poisonous have been accounted for from Molo (8,064 feet), Mau Summit (8,322 feet), Kinangop (10,000 feet), Kisumu (3,758 feet), Timboroa (9,000 feet), Meru (4,000 feet), Kabete (6,209 feet), Laikipia Plateau (7,000 feet), Nairobi district (5,400 feet), etc. During the course of this paper the locality where the different plants were collected will be noted, but it will be seen from the foregoing paragraph that poisonous plants have been obtained from many altitudes. The coastal belt, whose altitude does not exceed 600 feet, is very tropical and its forests are very rich in well known poisonous members, e.g. *Strophanthus* (Apocynaceae), *Sophora tomentosa* (Papilionaceae) from which a famous Swahili fish poison is made, *Erythrophloeum guineense* (Caesalpiniaceae) from whose bark the famous ordeal poison "Muavi" or "Mwai" is prepared, and numerous others.

Note.—In Part I of the paper the following poisonous plants will be described, viz. *Gloriosa virescens* (Liliaceae), *Cassia didymobotrya* (Caesalpiniaceae), *Ornithogalum longibracteatum* (Liliaceae), *Dichrocephala chrysanthemifolia* (Compositae), *Leonotis mollissima* (Labiatae), *Acokanthera Schimperiana et longiflora* (Apocynaceae), *Asclepias platycalyx* (Asclepiadaceae). All the above plants were collected by the

author and in every case confirmed by comparison with specimens in the herbaria of either the Government Mycologist (J. Macdonald, D.F.C., B.Sc., F.L.S.) or of the Forestry Department (H. M. Gardener, B.A.) or, in some cases, at both herbaria.

In subsequent parts poisonous plants, which require identification and are being submitted to Kew, will be described.

No. 1. *Gloriosa Virescens*, Lindl (Liliaceae).

Description of Plant.—"Stem long, branched, sarmentose. Leaves usually oblong or oblong-lanceolate, acuminate with a cirrluse tip, the lower verticillide or opposite, five to six inches long. Flowers forming a lax terminal corymb; pedicles long, cernuous at the tip. Perianth $1\frac{1}{2}$ to $2\frac{1}{2}$ inches long, shingly reflexing; segments lanceolate-cuspidate, scarcely at all crisped, $\frac{1}{2}$ inch broad at the middle, variable in colour, yellow or bright red, or in the original virescens, yellow tinged outside with green. Filaments about half as long as the perianth; anthers linear, 1 inch long. Style 1 to $1\frac{1}{2}$ inches long, branched in the upper third, capsule 2 to $2\frac{1}{2}$ inches long."

Synonyms and Vernacular names.—Superb lily. Mburiru (Kikuyu).

Distribution.—This plant is widely distributed throughout tropical Africa and extends into Rhodesia, Natal and along the East Coast of South Africa. In Kenya and Uganda it is ubiquitous and appears in profusion in the grazing during and at the end of the rainy seasons. In the intervals the plant dies down but when in full flower it is very conspicuous in the landscape and it is much sought after by native women for adornment of the head at the times of dances and other ceremonies.

The plant is closely related to *G. superba*, a very well known poisonous plant in India, Ceylon and Burma, which contains a poisonous principle known as superbin, chemically closely related to scillitin.

Literature and extent of present knowledge on toxicity of G. virescens.

According to Philips¹², quoting Medley Wood, the tubers of *G. virescens* are deadly poisonous, but no mention is made concerning the toxicity of other parts of the plant. Pammel¹³, Lander¹⁴ and Curson¹⁵, do not include the plant in their list of known poisonous plants.

The Kikuyu declare that the plant is very poisonous for all stock, but as it appears at a season when there is plenty of young grass, they do not consider that it causes any great loss.

Several years ago it was believed that ingestion of the plant was responsible for the disease known in the Ukamba district as "turning sickness." Feeding tests carried out with *G. virescens* not only failed to produce the typical turning movements, but they did not even poison the experimental animals. During the past few years there have been several isolated cases of the disease on farms in the Kyambu district, but unfortunately no investigation could be undertaken at the time.

The plant, even although it is of such deadly nature, has a natural enemy in the porcupine, which invades gardens and fields at the time the plants are in flower and roots them up in order to get at the tubers.

Parts of the plants proved poisonous.

The tubers contain a high amount of the poisonous principle, but all parts of the plant should be regarded as poisonous though the leaves, stem and flowers may be shown by feeding tests to be less potent than the root. Under experimented conditions cattle and sheep are very reluctant to eat the plant, even when very hungry, and in order to secure results feeding by drenching had to be relied upon. At the same time confirmatory tests were made with extracts of the plant. Sheep 2924 died after 1613 grams of leaves and bovine 4879 after inoculation of 100 c.c. 10 per cent alcoholic tincture of the leaves only. The acute cases were caused by intravenous inoculation of 20 c.c. watery extract of the roots of six plants.

Symptoms of poisoning caused by G. virescens.

(a) In acute cases the prodromal symptoms were uneasiness, salivation, conspicuous trembling of the lips and mouth, uncertain gait, drowsiness and hurried respirations up to 64 or more per minute.

Subsequently signs of abdominal pain were observed, such as kicking at the belly, gazing at the flanks and lying in the abdominal position in cool or stoney places. A diarrhoea soon appeared, and became more and more profuse, foetid and dark green. The watery evacuations eventually contained blood in increasing amounts. There was very marked tenesmus.

At the same time the animal appeared very drowsy, was unwilling to move, and if forced to do so, staggered about aimlessly. Sheep walked continually in small circles of a diameter of about five feet and always in one direction. If compelled to walk in the reverse direction they blundered into objects. Examination of the eyes of these animals showed at first impaired vision, but blindness supervened as the disease developed. Before the experiment these animals had perfectly normal vision and the onset of blindness was thus a remarkable feature of the disease. Clinical examination of the eyes failed to reveal anything unusual. The corneal reflexes were always very weak.

There was also acute respiratory distress which lasted until death supervened. The respirations were very rapid, of a blowing nature and accompanied by much grunting, moaning and a profuse slimey nasal discharge. During the height of the illness the sheep showed a very remarkable temperature, reaching 109° F. to 111° F., while control animals showed no elevation above 103° F.

The animals rapidly lost strength and often lay down for periods, but it was not unusual to find animals so fidgety that they could not adopt any one position for any length of time.

At times it seemed as if the sheep were trying to vomit. They stood with head and neck extended, salivating profusely and making chopping movements of the lips and jaws. In no cases, however, were there any ejections from the rumen.

In the final stages the diarrhoea simply poured out of the rectum. It was very watery, frothy and contained bright red blood, either clotted or liquid. The respiratory distress remained to the very end, the visible mucosae being much swollen and deeply injected, while there were repeated attempts at vomiting. There was no abatement in the severity of the symptoms, and before death the animal became comatose. Prostration was very great and the animals were totally indifferent to their surroundings. The high temperature was maintained through the illness.

(b) *In subacute or chronic cases.* These cases were observed in animals fed on small amounts of the plant, e.g. sheep 2924 received 1613 grams over a period of thirteen days before death supervened, and bovine 4879 received 50 c.c. of a weak watery solution of the leaves. No temperature was ever observed, but there were clinical symptoms of sub-acute

gastro-enteritis, i.e. constant colic, general uneasiness, lachrymation, unthriftiness, protration and intermittent foetid diarrhoea, which in the last few days contained a little blood.

Post-mortem Lesions.

(a) In acute or peracute cases.—There was considerable hyperaemia of the mouth, pharynx, oesophagus and of the mucosa of the first three stomachs. In the abomasum the laminae were very swollen and deep red in colour. There were numerous ulcers up to 2 cms. in diameter with raised angry borders, especially noticeable at the pyloric orifice. The intestinal mucosa was similarly affected but there was no ulceration. The contents of the abomasum and intestines were fluid and copiously intermixed with dark tarry blood. The caecum, colon and rectum were more mildly affected, but the blood in the contents was brighter in colour.

The parenchymatous organs were much swollen, very friable and saturated with blood. Removing the capsule of the kidney caused much tearing of the cortex in which there were numerous pin head haemorrhages. The blood was fluid, very dark in colour and stained very intensely. The spleen was very large and in one case (sheep No. 1) measured six inches in length and four inches in width. It showed marked "tumor splenis" and on the section a swollen, black, soft pulp. It was literally saturated with blood. There were a few petechiae on the epicardium and very numerous ones on the endocardium, while the heart was always markedly systolic. There was a haemothorax, the amount of blood varying up to 100 c.c. The mucosa of the respiratory tract was literally besprinkled with haemorrhages, while the lungs were saturated with blood and showed dark flesh-coloured solid areas up to the size of a pea. A foamy liquid oozed from the parenchyma on cutting into the organ. The bronchial tubes were full of whipped up froth which was slightly blood-stained.

In sheep No. 1 there were petechiae on the mucosa of the bladder. In all acute cases there were numerous pin-head haemorrhages, especially numerous in the vicinity of the optic papilla.

The subcutaneous vessels were markedly injected, while the general musculature was very much darker than normal.

Pathological anatomical diagnosis of acute cases.—Acute ulcerative haemorrhagic gastritis, acute haemorrhagic enteritis, haemothorax, acute congestion and oedema of the

lungs, retinal haemorrhages, congestion of all parenchymatous organs and the spleen, submucous and subserous petechiae, systolic heart.

(b) *In sub-acute and chronic cases.*—The carcass was generally in fair or poor condition, rigor mortis present. Extensive soiling of the perineum with liquid faeces was generally present. All the parenchymatous organs were enlarged, very friable and contained numerous putty-coloured areas. Lungs were congested and oedematous. A few petechiae were present in the left ventricle, while there were marked “tumor splenis.” The entire alimentary mucosa was swollen and a deep rose pink colour, it showed no ulceration.

Pathological History.

The microscopic anatomy showed acute hyperaemia of all tissues and organs with advanced “cloudy swellings” of the heart muscle, liver and kidneys; in chronic cases this condition had passed over to extensive fatty degeneration. The alimentary mucosa also showed marked stains of blood, while in the abomasum there was considerable erosion of the surface mucosa in places passing into direct ulceration.

Diagnosis.

It is obvious that the poisoning by *G. virescens* in the field will be a very difficult matter, as both its symptoms and pathology may be easily confused with some of the better known infectious diseases, with arsenical poisoning, and even with Acokantherosis.

The sudden onset, the peracute symptoms of gastro-enteric irritation, the development of ocular symptoms and the great prostration would suggest a poison. Arsenic can easily be proved by chemical analysis, but other poisonous plants may only be eliminated after a careful survey of the grazing.

The occurrence of cases simultaneously, the appearance of eye lesions and staggering and turning movements may cause confusion with Heartwater, especially the districts where bont tick flourishes.

In the Ukamba country Heartwater is known to occur, but it has never been definitely eliminated as the possible cause of the “turning sickness” which occurs in that country, and which is generally believed to be due to plant poisoning. Heartwater, however, can now be readily diagnosed by

the discovery of Rickettsia in the endothelial cells of the brain and kidney, while it may be transmitted experimentally by blood inoculation.

Gloriosa poisoning, therefore, will only be diagnosed by the discovery of portions of the plant in the ingesta of the animal at post-mortem, by its definite seasonal occurrence, and by the history that the plant in the grazing has been obviously eaten by cattle or sheep. The combination of advanced ocular lesions with acute gastro-enteritis should, however, suggest poisoning by this plant.

No. 2. *Ornithogalum Longibracteatum*. (Liliaceae.)

*Description of Plant**.—“ Bulb ovoid, 3 and 4 inches diameter. Leaves, 5 to 6 inches, lanceolate, flaccid, $1\frac{1}{2}$ to 2 feet long, 1 to $1\frac{1}{2}$ inches broad low down. Penduncle stout, stiffly erect, as long as the leaves. Raceme dense in upper half, 1 foot or more long; pedicels ascending or spreading, the lower 1 inch long; bracts very long, subulate from a lanceolate base, protruding beyond the buds. Perianth $\frac{1}{2}$ inch long; segments linear-oblong, whitish, with a broad green keel. Stamens shorter than perianth; filaments linear.”

Synonyms and Vernacular names.—“ Wild onion ” (Colloquial), Kikwashi (Kikuyu).

Distribution.—There are over one hundred species of *Ornithogalum* which are widely distributed through Africa, being very numerous in the Cape Peninsula. *O. thrysoides* is the famous “ chinkerichee ” or “ Star of Bethlehem.”

The present member is very prevalent in the Ukamba and Kikuyu districts of Kenya and grows in profusion in the vicinity of Nairobi. Like other Liliaceous plants it appears with the new grass during the rainy seasons. It is particularly fond of damp or marshy places and is often found near streams. After it has flowered it dies down only to reappear with the next rains.

It is regarded by the Wakamba and Wakikuyu as being excessively poisonous.

Literature, and present knowledge of toxicity of plant.

There is fairly extensive literature on poisoning by *Ornithogalum* species and the reader is referred to recent papers by Curson¹⁵ and Quin¹⁶. *O. sandersiae* have been

* *Flora of Tropical Africa*. Vol. VII, page 545.

found to be poisonous, while the present record is the first on the toxicity of the main East African species. Animals generally eat the plant while grazing on the veld, but it is often cut with grass and fed with hay. The latter occurrence has been noticed in South Africa.

Parts of the plant proved poisonous.

The root is the most poisonous part of the plant, the leaves and stems being considerably less toxic and only produce symptoms when given in large doses. Undoubtedly the amount of poison in those parts of the plant above the ground varies with the season of the year and is greater in the young plant in the flowering stage than in the old plant about to die down. This is quite in accordance with what has been observed in several other liliaceous plants.

The present investigation was conducted with a limited amount of material and in order to obtain results an extract was made from the roots and other parts of the plant by lixiviating with alcohol. This extract was subsequently inoculated subcutaneously into sheep. Intravenous inoculation was not practical as minced plant material, when mixed with water or alcohol, formed a stiff mucilaginous mass. The nature of the poisonous principle is quite unknown.

Symptoms of poisoning by O. longibracteatum.

1/11/29—Sheep No. 3 received 40 c.c. emulsion, representing 22.4 grams of fresh plant subcutaneously (20 c.c. being put into each thigh). Within a few hours the animal lay down continuously and refused to rise. At the site of inoculation there was still a small amount of the inoculum unabsorbed around which was a sinuous ring of a prominent reddish violet hue. Both limbs were very tender and warm. At the same time the animal went completely off its food and developed a "hang-dog" expression. Towards evening there was marked diuresis, while the stools were increased in amount, mashy in consistence, and dark in colour.

2/11/29.—The animal appeared very ill and absolutely refused to feed. Faeces were very copious, soft and slightly offensive. Diuresis was still very marked. Despite assistance the sheep refused to stand or move and examination of the local lesions showed complete absorption of the inoculum, but persistence of the tenderness and the red sinuous lines.

Respirations were quiet, but the animal frequently grunted and groaned.

Throughout the day the same symptom was shown.

3/11/29.—The animal was very weak and obviously dying. It lay in a corner, was very listless and totally apathetic to its surroundings. No diarrhoea, but there had been during the night numerous evacuations of large, dark, foetid stools. Diuresis was very pronounced and the stable floor was quite flooded. The local lesion showed no abatement, though all the inoculum had been absorbed.

Constitutional symptoms, e.g. anorexia, cessation of rumination, drowsiness, etc., were well marked.

Death occurred at 7.30 a.m. on 4/11/1929.

Sheep No. 3272 received 200 c.c. 10 per cent extract of the entire plant through the stomach tube. For a few hours it showed inco-ordination, jerky gait, salivation, dilated pupils and general uneasiness. Within twelve hours it had completely recovered.

Post-mortem lesions.

The carcass was in fair condition. Rigor mortis was not present. Visible mucosae were swollen, moist and much injected. There was a profuse slimy nasal discharge. No soiling of the perineal wool.

Subcutaneously, on the medial aspect of both thighs there were considerable necrosis of the subcutaneous tissues and gelatinous infiltration of the connective tissues. The red rings were due to an inflammatory zone in the skin and subcutaneous vessels.

There were 50 c.c. free blood in the thorax, while fluid in the serous and the pericardial cavity was greatly increased in amount (100 c.c.).

The heart appeared normal but the lungs were saturated with an oedematous fluid and contained much blood.

The liver and kidneys were very congested and friable, and contained large putty coloured areas.

There was marked tumor splenis, the pulp being dark in colour, containing very much blood and very soft. The mucosa of the abomasum and entire intestinal canal was swollen, soft, moist and varied in colour from a rose-pink to a deep claret. The most pronounced lesions were in the jejunum. No ulceration was noticed and the type of inflammation was distinctly haemorrhagic.

Pathological anatomical diagnosis.

Acute haemorrhagic abomasitis and enteritis; tumor splenis; oedema and necrosis of tissues of medial aspect of both thighs at sites of inoculation; congestion of liver and kidneys; haemothorax; hydropericardium; congestion of oedema of the lungs.

Pathological History.

The lesions on all the viscera were straight forward. Stasis was noticed in every instance, while there was advanced fatty degeneration of the liver and kidneys. In the case of the lungs there was increased oedematous infiltration both into the interstitial tissues and in the alveoli while the pulmonary vessels showed acute hyperaemia.

The mucosa of the abomasum and intestines showed marked stasis and in the jejunum rupture of the surface capillaries and the escape of blood into the lumen of the bowel had occurred.

Diagnosis.

The diagnosis of *O. longibracteatum* poisoning must necessarily be a difficult question, for the symptoms of illness are typical of any acute gastro-intestinal irritation such as may be set up by many other plants, e.g. *Acokanthera* species, etc. The history of the plant having been eaten by stock, the discovery of masticated fragments in the rumen, and the particular season of the year when the plants are particularly numerous in the grazing, are valuable aids in arriving at a diagnosis.

No. 3. *Dichrocephala Chrysanthemifolia*. Dc. *Compositae*.

Description.*

“ Erect herb, 1 to 5 feet high, simple or branched above; stem and branches terete, obscurely striate, shortly hirsute or shining and glabrate below. Leaves oblong or obovate, inciselyrate, obtuse or acute, dentate with petioliform auriculate-amplexicaul base, membranous, appressedly hairy; lower $1\frac{1}{2}$ to 4 inches long, upper shorter. Capitula globose or globose-oblong, many flowered, $\frac{1}{4}$ inch diameter, on unequal pedicles ranging up to $1\frac{1}{2}$ inches long, in lax terminal divaricate panicles. Scales of involucre six to eight, herbaceous, pubescent, ovate or elliptical or oblong, with membranous fimbriate-ciliate margins. Receptacle turbinate or

* *Flora of Tropical Africa*. Vol. III, 1877, page 303.

columnar, closely tuberculate, glabrous. Corolla of female fl. rotate-campanulate, three to four fid. Achenes compressed, glabrous, obovate."

Synonyms and Vernacular names.

Kullegab (Abyssinia); Kamugwata ng'ondu (Kikuyu).

Distribution.

According to Oliver and Hiern this plant belongs to "a small genus of the old world tropics." According to Philips¹⁸ one species (unfortunately its name cannot at present be traced) is found in South Africa, as a weed in Natal, Swaziland and the Transvaal. According to Oliver and Hiern, quoted previously, the plant has been collected from Abyssinia, Upper Guinea, the East Indies and Madagascar.

It is an annual herb which has a wide spread distribution in grasslands in damp localities. It has been found in abundance in the Kikuyu country between Nairobi and Kikuyu, while specimens have also been received from the Kinangop and the Mau escarpment. It has thus probably a wide distribution in the grasslands of the country between 5,500 feet to 10,000 feet in height.

Literature, and extent of present knowledge of toxicity of plant.

No reference can be found in the available literature or previous reports of the toxicity of this plant. According to Battiscombe¹⁹ the plant is "reported to possess properties similar to ergot." The source of the information responsible for this statement has never been found. Careful search through the records of this Laboratory has shown that no local experiments have ever been done on the plant, while Montgomery*, who was Veterinary Pathologist in 1915, knows nothing about the history of the toxicity of this plant.

It was with the object of elucidating what Battiscombe really means by the statement that the plant "possesses properties similar to ergot" that the following feeding tests were carried out at Kabete.

Chronic ergotism in the domestic animals, as is well known, is manifested by symptoms of gastro-intestinal catarrh, anaesthesia and dry gangrene of the feet, ears and tail, and in poultry of the comb, tongue and beak (Lauder). Abortion ensues in pregnant animals (Winslow). It will be

* Private communication.

seen from feeding experiments that acute cases of poisoning caused by ingestion of this plant failed to set up any symptoms which might be compared to ergotism, while abortion did not occur in pregnant ewes.

For the experiments young fresh plants in flower were obtained and as the sheep refused to eat the plant, drenching of chopped material through a stomach tube was relied upon.

Parts of the Plant proved Poisonous.

No detailed experiments were carried out to find out which was the most toxic part of the plant, nor was any attempt made to work out the active principle.

As mentioned in the preceding section, the entire plant minus the roots were used in these experiments. In ewes Nos. 2854 and 3085 only 1584 grams and 1602 grams were sufficient to cause death.

Symptoms.

Ewes in advanced pregnancy were used for the tests. The symptoms were always those of an acute gastro-enteritis, i.e. marked abdominal pain, general systemic disturbances and profuse diarrhoea, which was at first greenish in colour, pultaceous, but becoming more and more liquid and finally containing shreds of mucous and streaks of blood. As the disease progressed the animal rapidly weakened, lay down continuously and appeared heavy and drowsy. In the meanwhile the diarrhoea continued to be very profuse and watery, while the respirations were laboured and accelerated up to 42-50 per minute. There was no rise of temperature during the illness, but always a profuse clear slimy nasal discharge. Before death the animal was prostrated and passed into a state of deep coma.

Occasionally there were no clinical symptoms at all (ewe No. 2824) and death occurred very suddenly and quite unexpectedly.

In no case, despite the acute gastro-enteritis and the profuse watery evacuations from the bowel, did abortion occur.

The mortality was 100 per cent in the experimental animals.

Port-mortem lesions.

The carcasses were in fairly good condition and when there had been profuse diarrhoea during life the perineal wool was soiled by liquid faeces. Visible mucosae were swollen, moist and reddish in colour or even cyanosed. In ewe No. 3085 there was a slimy nasal discharge.

The parenchymatous viscera were not constantly altered. In ewe No. 3085 the heart was flabby and dilated, but cardiac haemorrhages were never noticed. The liver and kidneys were either apparently normal or the seat of pin-head haemorrhages complicated by "nutmeg."

The spleen showed a variable degree of "tumor" and the pulp was soft, swollen and dark in colour.

Beyond than containing more than the normal amount of blood and having a "dingy" consistence the lungs showed nothing marked.

The blood was liquid, black and tarry. It coagulated slowly but stained well.

The mucosae of the upper respiratory and alimentary tracts showed a variable degree of injection of the surface vessels.

The main lesions were found in the abomasum and intestines. The mucous membrane was swollen, moist and deeply injected, the colour varying from a deep rose pink catarrhal material. The lesions were most pronounced in the abomasum and the upper half of the small intestine, the severity decreasing towards the rectum. The laminae of the abomasum were very soft, much swollen and infiltrated. There was considerable stasis in the mesenteric vessels covering the peritoneal covering of the abomasum and duodenum.

The uterus, in pregnant ewes, contained a foetus near full term. Some of the material cotyledons showed a few pin-head haemorrhages, while the mucosa was a little more injected than normally. However, these lesions were very mild and there were no indications that abortion would have occurred if the dam had lived. In neither case did the foetus show any lesions.

Pathological Anatomical Diagnosis.

Acute haemorrhagic gastro-enteritis; tumor splenis; haemolysis of the blood; mild congestion and fatty degenerations of the liver and kidney parenchyma; oedema and congestion of the lungs; mild injection.

Pathological History.

There were no specific lesions. The microscopic changes in the various organs agreed with the lesions seen with the naked eye. The gastro-enteric changes were due to a straightforward inflammation accompanied by a haemorrhagic exudation.

There was no disorganisation of the surface epithelium. In the parenchymatous viscera and spleen there was more or less considerable hyperaemia with a varying amount of fatty degeneration in the former structures. The maternal cotyledons were normal.

Diagnosis and Discussion.

There are no pathognomonic symptoms or lesions of poisoning by this plant and in order to arrive at a diagnosis the usual procedure recommended in cases of obscure plant poisoning would have to be adopted, viz. elimination of the commoner infectious diseases and arsenical poisoning; the discovery of pieces of plant in the ingesta; the survey of the veld for irritating or poisonous plants; the finding of material obviously recently grazed upon by cattle; and finally the history of the case. In practice, attention should be paid to the possible role of this plant in those cases of abortion which are complicated by the fatal haemorrhagic gastro-enteritis. It is of course desirable that the active principle of the plant should be isolated and tested pharmacologically on the mammalian uterus.

No. 4. *Cassia Didymobotrya*. Fresen. *Caesalpinia*cae.

*Description.**

" A shrub or small tree of 7 to 10 feet; branches and leaves at first puberulous or finally pubescent. Leaves 6 to 12 (- 16) inches long; rachis pubescent, plane or slightly convex above, sometimes faintly sulcate when dry; glandular or with a rudimentary gland between some of the leaflets, leaflets in 8 to 16 pairs, oval-oblong or oblanceolate-oblong, apex round with a conspicuous slender mucro, obliquely rounded at the base, finely pubescent or nearly glabrous at length, 1 to 2 or $2\frac{1}{2}$ inches long, 5 to 9 lines broad; subsessile or petiolules half line. Stipules ovate-rotundate, apiculate, reflexed, deciduous, less than $\frac{1}{2}$ inch long. Racemes simple, erect $\frac{1}{2}$ to 1 foot long, from the axils of the uppermost leaves, solitary or from 2 or 3 to 6 or 8 collected about the ends of the branches, equalling or avertopping the leaves. Pedicels $\frac{1}{8}$ to $\frac{1}{4}$ inch. Flowers at first closely packed with elliptical or ovate imbricating caducous bracts $\frac{1}{2}$ inch long more or less. Sepals nearly equal in length, the posterior broader, obtuse. Petals obtuse, strongly veined, very shortly clawed. Two of the anterior anthers much enlarged, curved 5 to 6 inches

* *Flora of Tropical Africa*. Vol. II, page 277.

long. Legume two-valved, flat, linear-oblong, slightly sinuous in our specimens, narrowed below into stripes of $\frac{1}{4}$ to $\frac{1}{2}$ inch, and above to the persistent base of the style; 3 to 4 inches long, in broad. Valves thinly coriaceous, transversely depressed between the (9-16) seeds when dry. Seeds horizontal, obovate-oblong, with a narrow linear areole on each face, compressed in the same plant as the valves; cotyledons enclosed between moderate layers of albumen, in transverse section of the seed extending from end to end, slightly sinuous or plane."

Synonyms and Vernacular names.

Wild senna; Mwena (Kikuyu); ol-Senetoi (Masai); Senetuet (Nandi and Lumbwa); Owinu (Jaluo); Kilao (Meru).

Distribution.

A very common and widely distributed small tree, which grows in Kenya between the altitudes of 3,000 and 7,000 feet. It is particularly fond of damp localities, but at the higher altitudes it may be found away from water. There are over 470 species of *Cassia* found in all warm or tropical countries. When in flower this plant is very conspicuous on account of "its racemes of yellow flowers topped by heads of immature buds almost black in colour." (Battiscombe¹⁹). It has a peculiar odour which is said to drive bees out of house.

Literature, and extent of present knowledge of toxicity of the plant.

The genus-*Cassia* contains several plants of economic medicinal importance, e.g. *C. augustifolia* and *C. acutifolia*, the leaves of which constitute "senna tea," the well-known anthracene purgative.

Lander does not mention any poisonous *Cassia*, but Pammel includes in his catalogue of the poisonous plants of the world, the names of thirteen species including *C. didymolohya* and *C. sophera*, which have been recently investigated in Kenya and New South Wales respectively. Seddon²⁰ and Carne, however, have recently failed to prove the poisonous nature of *C. sophera* in a hogget which was fed on 2 lb. of dried stalks.

C. didymobotrya has been reputed from Abyssinia and Tropical America, but Pammel does not state whether the plant has been definitely proved poisonous or whether it is included in his list because it has definite medicinal virtues.

Pammel also mentions *C. kituensis*, which from its specific name would appear to come from the Kitui district of Kenya. Nothing, however, is known of the toxicology of this plant.

A further species, *Cassia obovata*, has been proved poisonous to stock in South Africa. (Phillips¹²).

The value of an infusion of the leaves of *C. didymobotrya* as a purgative is well known to the Masai of Kenya¹⁹ and these people also believe that the plant possesses very efficient properties in the treatment of malaria. Drastic doses of the infusion are said to cause abortion in pregnant women, but whether this is due to specific physiological action of some active principle on the uterus or whether the abortion results reflexly as result of intense congestion of the pelvic viscera, as may happen during the use of any violent purgatives, e.g. aloes, cannot be said, and no effort is made in the present paper to throw any light on the question.

Most of the genus *Cassia*, however, apparently have laxative or purgative properties according to the dose of material given.

When given in extreme doses any of the Anthracene purgatives, e.g. senna, rhubarb, cascara, etc., may cause great irritation, prostration, gastro-enteritis and even death (Cushny).

Parts of the plant proved poisonous.

Feeding tests show the very high toxicity of the leaves. Thus, sheep No. 3074 succumbed after drenching with an infusion made from 180 grams of leaves, and sheep No. 3086 after a drench made from 74 grammes. The pods are apparently more harmless and sheep No. 4 showed no symptoms after dosing with an infusion made from 400 grams of pods.

The roots, flowers and stems were not experimented with. Rabbits, after ingestion of a couple of leaves, showed a tucked-up abdomen and increased defaecation of small softish stools in place of the normal pellets. If the number of leaves was increased a watery diarrhoea supervened, but otherwise completely recovery occurred.

As far as the writer could determine the Masai use about a dozen leaves for their purgative infusion.

Symptoms.

The symptoms, when noticed, were those of an acute gastro-enteritis accompanied by the usual systemic disturbances.

Before death the purgative action of the plant was very marked but dysentery was not noticed. At the same time the animal appeared weak, staggered when forced to move and, before decease, became comatose. In one case which received 180 grams fed over two days death occurred suddenly without any premonitory symptoms. In the second animal which received one dose of 75 grams the above symptoms were accorded.

Post-mortem lesions.

The following post-mortem lesions were recorded, viz. :—

(a) Petechiae on the epicardium and endocardium.

(b) Marked tumor splenis. Capsular petechiae in sheep No. 3074.

(c) Hyperaemia of the respiratory mucosa and oedema of the lungs.

(d) Congestion and fatty degeneration of the liver and kidneys.

(e) The abomasum only showed a mild degree of hyperaemia. In the small and large intestines the mucosa was swollen, infiltrated and presented numerous pin-head haemorrhages, which were generally aggregated into extensive clusters, resembling extravasation. The contents of the entire bowels were liquid. No ulceration was noticed.

Pathological history.

This was quite straightforward and corresponded with the naked eye anatomy of the changes in various organs.

General hyperaemia and fatty changes in the parenchymatous viscera appear pathogonomic of irritant vegetable poisons.

Diagnosis.

As has already been discussed under poisoning by *Dichrocephala*, *Ornithogalum*, etc., the diagnosis of poisoning by comparatively little known plants is largely based on circumstantial evidence and after the exclusion of the more obvious infectious diseases. Naturally the discovery of the plant in the ruminal ingesta and for the actual observation of animals feeding on the plant is positive proof, but generally

the diagnosis of poisoning is a difficult affair and may only be made after a careful survey of the veld and the collection of plants capable of causing fatal gastroenteric symptoms.

No. 5. *Asclepias Physocarpa*, Sell. *Asclepiadeae*.

Stem 2 to 3 feet (or more) high, branched, whitish-pubescent or sub-tomentulose in the upper part. Leaves opposite, ascending or spreading; petiole 2 to 3 inches long; blade 2 to 4 inches long; $3\frac{1}{2}$ to 10 inches broad, lanceolate, very acute, mucronulate, cuneately acute at the base, glabrous on both sides, but with the petiole and sometimes the midrib more or less puberulous. Umbels 6-10 flowered; peduncles sublateral or subaxillary, 1- $1\frac{1}{2}$ inches long, whitish-pubescent at the top; pedicles 7-12 inches long, whitish-pubescent. Sepals 2 inches long, lanceolate, acuminate, pubescent. Corolla five-lobed nearly to the base; lobes reflexed, about 3 inches long, 2 to $2\frac{1}{2}$ inches broad, ovate, subobtusate, glabrous on both sides, but siliate along one margin within, white. Coronallobes arising $\frac{1}{2}$ -1 inch above the base of the staminal-column, and nearly or quite reaching to its top, about 1 inch long, complicate, subquadrate in side view, apical angles of the inflexed sides shortly produced above the other part of the lobe into a broad subtruncate lobule, usually produced into an erect tooth on the dorsal side, narrowly winged down the inner margins, no tooth within. Staminal-column about $2\frac{1}{2}$ inches long; anther-appendages transverse, somewhat semi-circular, inflexed over the margin of the depressed apex of the style. Follicles $1\frac{1}{2}$ to $2\frac{1}{2}$ inches long, $1\frac{1}{2}$ to 2 inches diameter; solitary, inflated, subglobose or obliquely ovoid, obtuse, puberulous and covered with long soft bristles."

Synonyms and Vernacular names.

Milkweed or bindweed (European); Chepkuinaba (Lumbwa); Mwanja and Mukangarithi (Kikuyu).

Distribution.

"A woody herb up to 5 feet, very common in damp localities, in grasslands at an altitude of 6,000 to 8,000 feet. A strong fine fibre is obtained from the bark." (Battiscombe.)

This plant is most widely distributed member of this family in the settled areas of Kenya. Another closely related shrub is *A. leucocarpa*, which is found in the Athi and Kapiti Plains near Nairobi. It has the reputation amongst the Masai

of being highly poisonous, but no confirmatory feeding tests have yet been carried out with it, so that for the time being it must remain suspect.

According to the Flora of Tropical Africa *A. physocarpa* has been collected from "Laikipia, Uganda and the country between Eldama Ravine and the upper Mau plateau." To these localities must be added the Nairobi district, Kikuyu grasslands, the Kedong and Rift Valleys (settled areas at any rate) and the Athi Plains. It also occurs in the Lumbwa and Nandi countries.

It is very clear that the plant is widespread throughout the Colony. Possibly it is found in other parts of the continent for the genus is essentially an African one.

Literature, and extent of present knowledge of the toxicity of the plant.

The Asclepiadaecea contain many plants of great interest, but some of them are excessively poisonous. C. D. Marsh and A. B. Clawson²² in a recent bulletin dealing with *Asclepis mexicana* as a poisonous plant have reviewed the literature on harmful *Asclepias* in different parts of the United States. As far as the writer can ascertain from the available literature no poisonous *Asclepias* have been reported from South Africa, though Curson's paper¹⁵ on *Cynanchum africanum* is of interest since that plant belongs to the Asclepiadeae.

Freidberger and Frohner²³ mention poisoning by *Asclepias vinetoxicum* (common or great celandine). The symptoms were strangury, diabetes, cachexia and general weakness, while the autopsy showed nephritis and cystitis.

The nature of the toxic principle or principles is not well known. Some plants, e.g. *A. tuberosa* and *A. incarnata*, are said to contain a bitter glucoside known as asclepidin. No attempt was made in the present investigation to determine the active principle of *A. physocarpa*.

It would seem desirable to suspect all members of this genus as possibly poisonous until carefully conducted experiments have proved the contrary.

Parts of the plant proved poisonous.

Marsh and Clawson, investigating *A. mexicana*, found that the toxic principle was found very largely in the leaves, but that the whole plant and the stems were capable of

producing sickness but not necessarily death. Apparently in those experiments "no animals were killed by the feeding of the stems." The root was not tried. In the poisoning by great celandine recorded by Friedberger and Frohner the root was said to be particularly toxic.

In our local experiments the leaves freshly picked and a few flowering umbels were used. No distinct tests were made to find out whether the leaves were more poisonous than the flowers, or vice versa, but it would appear from the relatively little flower material used that the leaves were the most poisonous part. Altogether 1772 grams of plant were given, mainly in form of a drench containing finely minced material to a sheep weighing about 120 lb. In comparison with the figures presented by Marsh and Clawson, it is clear that larger doses of *A. physocarpa* (3.9 lb.) are required to cause poisoning than *A. mexicana*. The actual feeding lasted over five days and symptoms were remarkably late in developing.

Symptoms.

Very few symptoms were noticed. During the fourth and fifth days of feeding the temperature ascended to 105.2° F. and remained about that height until death. The animal at this time appeared weak and unable to stand or it staggered about with great difficulty. No other symptoms were noticed and the animal was found dead. Several cases showing clonic spasms were not observed. (*Vide* paper by Marsh and Clawson.)

The slowness of development of the symptoms caused by poisoning by this plant has already been noticed and it is in agreement with the experiments of Marsh and Clawson.

Post-mortem lesions.

The carcase was bloated and foam issued from the nostrils. The condition was good. There was congestion and oedema of the lungs with intense hyperaemia of the trachea, pharynx and larynx, and numerous ventricular petechiae in the heart.

The abomasal mucosa showed numerous haemorrhages on the laminae and fundus, while the pylorus was more lightly affected.

The small intestine was less petechiated than the abomasum and the haemorrhages were very scattered or isolated.

The parenchymatous tissues were light in colour and soft while the renal cortex contained numerous pin-head haemorrhages.

Pathological Anatomical diagnosis.

Hyperaemia of pharynx, larynx and trachea; congestion and oedema of the lungs; petechial haemorrhages in the abomasum and small bowel; congestion of the kidneys; cardiac haemorrhages; fatty degeneration of the parenchymatous viscera.

Microscopic Anatomy.

There were no remarkable microscopic lesions, which in general correspond with the naked eye changes. Liver, kidneys and myocardium all showed more or less extensive degenerative changes while in the lungs, gastro-intestinal mucosa, kidneys, trachea, larynx and pharynx, there were very acute congestion of the capillaries with the exudation of a little oedematous fluid.

Diagnosis and discussion.

Unless there is positive evidence of the animal having eaten the plant a diagnosis is likely to prove most difficult, more especially as symptoms may be late in developing. There are no typical symptoms and the numerous ones that may be present may lead to a suspicion of Heartwater which, however, may be excluded by the failure to transmit the disease by blood inoculation and by the absence of Rickettsia. There may also be difficulty in excluding *Gloriosa virescens*, especially when that plant is in full bloom. It would seem, therefore, that in most cases, except when positive evidence, e.g. actual discovery of the plant in the rumen, etc., is forthcoming, the diagnosis will be very difficult.

No. 6. *Leonotis Mollissima*. Gurke. *Labiatae*.

Description.*

"A perennial herb, with finely pubescent branches. Leaves distinctly petioled, ovate, the lower 3 to 4 inches long, subacute, cordate, crenate, thinly pubescent and green above, densely matted with soft white pubescence beneath. Whorls 2 to 3, dense, $2\frac{1}{2}$ inches diameter; pedicels very short; bracts small, subulate, mucronate. Calyx pubescent, $\frac{1}{2}$ inch long; teeth lanceolate-mucronate, the upper one much the largest. Corolla 1 inch long, very hairy, bright orange varying to pale yellow and pale red. Stamens included."

* *Flora of Tropical Africa*. Vol. V, page 493.

Synonyms and Vernacular names.

Muchii (Kikuyu); ol-jujunoi (Masai).

Distribution.

This is a very widely distributed herb which favours uncultivated lands, derelict native villages and plantations.

It is found at an altitude of 4,000 to 7,000 feet and is very common in the Kikuyu country between Nairobi and the Escarpment. Several species exist in South Africa where the leaves of *Leonotis leonurus* are smoked by the natives like those of Indian hemp (*Cannabis sativa*), producing a similar stupefying effect (Marloth²⁴).

The leaves of *L. ovata* are used in the Eastern provinces with a like effect and are said to be useful in reducing over-corpulence and as a remedy against snake-bite. While the former exists in Tropical Africa south of the equator, it has not been recorded from East Africa.

Literature, and extent of present knowledge of toxicity of plant.

As far as can be gathered from the Kikuyu no use is made of the leaves of *L. mollissima* for medicinal or other purposes. They do not regard the plant as poisonous, but they maintain that animals do not eat it in any abundance because of the needle-like sharpness of the calyx teeth.

Goats, however, nibble at the lower leaves of the plant, but show no liking for large amounts.

No mention is made of the genus by Lander, while Pammel mentions *Leonurus cardiaca* L. (Motherwort) as containing "a volatile oil with an unpleasant odour, a bitter pinciple, etc.," though he adds that the stiff bristles of the calyx are often injurious and cause mechanical injuries. In the available literature no mention can be found of an investigation into this genus in South Africa.

Parts of the plant proved poisonous.

Only the leaves and flowers were fed and as sheep absolutely refused to touch them they were passed through a fine mincer and fed through a stomach tube. In this way 1867 grams were administered over a period of seven days. The teeth of the calyx were finely cut up, but could be picked out of the drench on account of their sharpness.

Symptoms.

The symptoms during the last forty-eight hours of life were those of a gastro-enteritis manifested by abdominal pain, increased defaecation and general systemic disturbances of a mild degree. During this time the animal reclined in the sternal-abdominal position as if seeking relief for its colicky pain from the cement stable flooring. Death occurred suddenly and was unexpected.

No rise of temperature was recorded. Rabbits drenched with 20 c.c. of an infusion on two successive days also died very suddenly.

Post-mortem lesions.

Good condition of the carcass. The animal was very blown and liquid blood oozed from the natural orifices.

Throughout the entire gastro-intestinal canal the mucosa was very swollen, moist and varied in colour from a rose-pink to a deep port wine. It was most marked in the pyloric region of the abomasum, duodenum, and first part of the jejunum. No ulceration was noticed.

The liver, kidneys and myocardium were pale in colour, friable and moist. The lungs were somewhat inflated, very doughy and deep red in colour. The heart appeared normal, but showed post-mortem discolouration of its serous surfaces. There was marked tumor splenis.

The uterus contained a full term female foetus, which was apparently normal.

Pathological Anatomical diagnosis.

Acute hyperaemia of stomach and intestines; tumor splenis; fatty degeneration of parenchymatous organs; congestion and oedema of the lungs.

Microscopic Anatomy.

Acute stasis of all organs and viscera with advanced fatty changes in the myocardium, kidneys and liver.

Diagnosis.

Poisoning by *L. mollissima* presents no characteristic features. It is obvious as in many other cases of plant poisoning a positive diagnosis can only be returned when there is a history of the animal having been seen to eat the plant or when the plant in various stages of maceration is found in

the paunch. However, the presence of this herb in the grazing is a danger, for in times of drought its attractive green leaves and orange red flowers may tempt a half-starved animal.

Whenever the cause of cases of acute gastro-enteritis is being searched for, the possible role of this plant should receive attention and consideration.

No. 7. *Acokanthera Schimperii*. Schweinfel A. *Longiflora*.
 Stuff. *Apocynaceae*.

In a previous paper³ poisoning by these shrubs or trees was considered and it is not intended to recover the same ground. During the past thirty months further information regarding the incidence of Acokantherosis or the toxicity of the trees at various seasons, the type of animal susceptible to poisoning, etc., has been obtained and will be presented in this paper. There is no doubt that poisoning by either of these trees is very prevalent in Kenya and responsible for considerable loss every year.

It is remarkable that both Pammel and Lander give such meagre information on this subject, more especially since Burton²⁵ and other African pioneers have repeatedly drawn the attention of their readers to the famous Somali and East African arrow poisons.

Thus Burton, in his famous book "First footsteps in East Africa" gives detailed experiments carried out in 1853 by Arnott who used "a substance procured near Aden and used by the Somalis to poison their arrows." This Somali poison is identical with the famous poison used by the Wandero-bo, Nandi, Wakamba and other hunting tribes of East Africa. The experiments of Arnott²⁶ do not show the great toxicity of the poison, as they appear to have been carried out with badly prepared material.

The first authentic record of Acokantherosis in East Africa was reported by Sturdy¹ in a series of well executed experiments, and our results confirm his, which were carried out nearly twenty years ago.

For the preparation of this poison the leaves, young twigs, bark or roots are employed. A decoction is made and boiled for six or eight hours until a dark tarry treacle-like residue is left, which is stored away in sheets of bark of certain trees. To this is added by some tribes, e.g. Wakamba,

the head of a poisonous snake, the venomous parts of biting spiders and various other roots, one of which appears to be the ordinary common aloe. That the poison is very potent there cannot be any doubt, for an animal wounded in a fleshy part dies in some fifteen to thirty minutes. The flesh around the arrow puncture is cut away and the other parts of the body are considered fit for consumption.

Extracts of different *Acokanthera* are used through Africa for the manufacture of arrow poisons. Presumably, therefore, they must be listed amongst the known poisonous plants. In Somaliland *A. ouabain* is used, while in Yemen and Eruthraea *A. deflersi*, in East Africa and Abyssinia *A. schimperi* and *A. longiflora*, and in South Africa *A. venenata* are employed, while certain authorities contend that the famous "fra-fra" poison of the Gold Coast is made from an *Acokanthera*.

It will be noticed that *Acokanthera* trees have a very wide distribution in tropical Africa, but it is astonishing to find from perusal of the literature how little is known about the poisoning of man and the domestic animals by these trees.

The subject is really a very important one both from the veterinary and medico-legal aspects. Malicious poisoning, both of human beings and animals, is not uncommon in savage tropical Africa, but as a rule only the fetish man or witch-doctor is able to administer virulent poison in an acceptable form. At the present day when a native tries to poison a European, he administers strychnine or arsenic or some of the common dips containing arsenical preparation, instead of the plant poisons of which his fetish man has such a profound knowledge. In Eastern Africa, extracts of *Acokanthera* or *Strophanthus* are made use of and peculiarly enough they both belong to the same family and act specifically on the heart.

That the wilful destruction of a settler's stock by the native employees in Kenya does occur is certain. In some instances arsenic or strychnine or other drugs of European origin have been inculpated. In other cases, since chemical analysis failed to find any drug of known composition, it was believed likely that a vegetable poison of unknown structure was employed.

During the past two years the writer has investigated, at the request of the medical authorities, two plants obtained from totally different parts of the country, used by natives for

the purpose of wilfully murdering rivals. One case came from Meru, in the region of Mount Kenya, and the plant was easily proved to be an *Adenia* (Modecca) which is excessively poisonous for sheep and rabbits in small doses. The second case was reported from Kisumu on the shore of Lake Victoria-Nyanza, in Central Kavirondo. Here the root of shrub or small tree, called in the Ja-Luo dialect "Owoho" was obtained by the District Commissioner and said to be the responsible agent, the dry root being pulverised and secretly added to the victim's porridge. The identity of this plant is not yet known, but specimens are being submitted to the Royal Botanical Gardens, Kew. It is hoped to deal more fully with those two interesting instances of malicious poisoning in part 2 of this paper.

Finally, it may be added as a matter of interest, that Acokantherin, the glucosidal principle of *A. venenata*. Don, has been compared pharmacologically and physiologically with digitalin, the active principle of the purple fox-glove *Digitalis purpurea*. In every respect Acokantherin was found to be inferior to the older drug.

Susceptibility of various domestic animals to Acokanthera poisoning.

All the domestic animals, including the dog and cat, are highly susceptible to *Acokanthera* poisoning while, according to the testimony of native hunters, all birds and mammals can be slain by arrows anointed with the properly prepared extract of *A. schimperi*.

At Kabete, cattle, sheep, goats and rabbits were readily killed by the intravenous, intramuscular and subcutaneous routes, while drenching with an infusion of leaves or stems was always fatal. Arnott noticed that the mere placing of a little extract within the external ear of sheep caused death in two hours.

That the poison may be absorbed through the skin is well known to the native medicine men who prepare the poison, for during the operation they literally smear themselves with wood ash or with the juice of one of the wild sages. (*Coleus species*.) Inhalation of the dry powdery residue is also said to be attended with fatal consequences, showing that absorption may occur through the respiratory mucosa. Curson¹⁵ has recorded the poisoning of donkeys by *A. venenata* in South Africa.

In the following table the rapidity of the poison is noticed, viz.:—

No. of Animal	Interval after Dosing	Amount and Channel of Inoculation
Sheep 2958 ..	73 minutes	Per os., 200 c.c. of infusion.
Sheep 2961 ..	125 „	ditto
Sheep 2957 ..	27 „	Subcutaneously, 25 c.c. of infusion.
Sheep 2939 ..	17 „	Intravenously, 10 c.c. of infusion.
Goat 306	21 hours and 55 minutes	Per os., 200 c.c. of infusion.
Rabbit No. 1 ..	„ minutes	Per os., 10 c.c. of infusion.
Rabbit No. 2 ..	14 „	Intravenously, 5 c.c. of infusion.

The infusion used was made by pouring two litres of boiling water on a kilo of crushed leaves and finely chopped young stems and decanting the sherry-coloured liquid.

Cattle were not experimented with.

The apparent greater resistance offered by goats as shown in the above table, although only one animal was tried, is in accordance with native testimony. African goats are exceedingly hardy animals and will browse with relish on plants which other animals, even half starved, will consistently refuse to touch.

These intervals after dosing compared favourably with those noticed by Stordy and Curson in their experiments.

Carnivora, like dogs and cats, may be poisoned if the extract is given, otherwise than through the alimentary canal. Stordy and Curson have shown that although the dog may be gravely ill after swallowing a pill made from the treacle-like extract, its ability to rid its stomach of the poisonous matter by repeated vomition saves its life and it subsequently slowly recovers.

Under natural conditions in the field Acokantherosis has been diagnosed in cattle and sheep. In both animals cases always occur in time of drought when there is practically no grazing. In sheep, cases have been reported from the estate of Messrs. Shaw Brothers and Mathias, Laikipia

plateau, while in cattle serious outbreaks of poisoning have been reported from Laikipia, Ngong forest area, near Naitobi, Machakos area and the Rift Valley.

Acokantherosis in sheep under natural conditions.

On the evening of October, 1929, a sick sheep arrived at the Laboratory for post-mortem examination. With it came the following history :—

During the previous day, out of a large flock of sheep, (two toothed) thirty died very suddenly. Most of them showed no symptoms of any kind, but in a few cases there was profuse liquid green diarrhoea, a high temperature varying between 105° F. and 108° F., marked salivation, giddiness and inability to stand.

Most of the cases were post-mortemed by Mr. Shaw, the owner of the farm, who noted acute gastro-enteritis and congestion of the lungs. He was particularly struck with the rapid post-mortem exfoliation of the mucosa of the rumen and in every case found considerable quantities of partially macerated fresh green leaves and twigs of the murichu tree (*Acokanthera schimperi*) in the ruminal ingesta.

The animal that arrived at the Laboratory showed the following symptoms :—

Rapid jerky grunting respirations; profuse clear, slimy nasal discharge; marked congestion of the visible mucosa; rectal temperature of 105° F., a very uneasy and anxious expression and extensive soiling of the perineal wool by liquid faeces. The animal was immediately killed and showed the following lesions, viz. endocardial petechiae; slight tumor splenis; congestion and marked oedema of the lungs; congestion of all the parenchymatous organs; hyperaemia and oedema of the gastro-intestinal mucosa, while there was a very considerable amount of murichu material in the rumen.

The mildness of the above symptoms and lesions leave the impression that this animal would have recovered and according to further information from Laikipia, all the animals which showed a similar degree of illness got better. It is impossible to give figures as to the number of animals which actually ate murichu, but it is known definitely that thirty died and only five showed signs of illness. Mr. Shaw considers it possible that only thirty-five animals grazed off the tree, which was only a young sapling, and if these figures

are correct the mortality was round about 86 per cent. At this season of the year the grazing was very scarce and the sheep were eating all sorts of non-graminaceous material.

In reviewing this outbreak of Acokantherosis amongst sheep there are many points of great importance, e.g. the rapidity of the action of the poison, the complete absence of symptoms in most cases, and the high mortality. All these factors would suggest at first glance an acute infectious disease and if definite vegetable material had not been found in the rumen a provisional diagnosis of Heartwater would certainly have been returned.

Acokantherosis in cattle under natural conditions.

This subject has already been discussed in a previous paper, but outbreaks of poisoning are constantly occurring all over the country and are probably much more common than is even now imagined.

The history is nearly always the same, i.e. sudden deaths with or without symptoms leading the owner to suspect Anthrax. If symptoms are noticed they are those referable to acute congestion of the lungs and acute gastro-enteritis.

In a certain instance a farmer lost only one animal and he suspected arsenical poisoning or result of some mishap during dipping. Various viscera, including the ruminal contents, were submitted for chemical analysis, of which the result was negative. During examination of the ruminal contents murichu leaves and twigs were found in great abundance, leaving no doubt as to the real cause of death. Further enquiries elicited the information that murichu trees were numerous on the farm and showed signs of having been grazed. This was really an important observation as it showed that isolated cases of Acokantherosis may occur. Clinically arsenical poisoning and Acokantherosis are very similar, but to the observant pathologist there are differentiating post-mortem characters, e.g. better preservation of the carcase and the peracute ulcerative condition of the stomach and intestines in arsenical poisoning, the marked pulmonary oedema and systolic heart in the case of Acokantherosis.

Heartwater is another disease which may cause confusion, but as a rule it is not accompanied by such marked generalised inflammatory lesions as in Acokantherosis, while of course both the pericardium effusions and the history of the violent maniacal tendencies before death are very characteristic of this disease in cattle.

As in sheep, the poisoning is always noticed towards the end of the long dry season when the grazing is practically nil. The glabrous deep green leaves of all *Acokanthera* are very striking and must be sore temptation to half starved beasts.

The periods of greatest toxicity of Acokanthera shrubs and trees.

Information which is being steadily collected shows that *Acokanthera* species are not equally poisonous at all seasons of the year. It is undoubtedly most toxic at the very time when cattle are most likely to eat it, i.e. during the dry seasons of the year, while certain feeding experiments with *A. longiflora* carried out during the short rains of 1927 showed that this species, at any rate, was much less toxic at this time than it was when experimented with a few months earlier, which happened to fall in the short dry spell, between the long and short rains. It is very well known that many plants vary in their toxicity not only at certain seasons but when grown under different climatic and telluric conditions.

The same observation was made by Curson in South Africa. All parts of the two common *Acokanthera* trees are not poisonous. The fruits are quite edible if bitter, and are used by some settlers for the manufacture of jam or preserve. The roots, bark of the main stem, flowers, young fresh leaves and branches are very poisonous, while the older leaves and branches are less so. In connection with the previous statement, however, Curson has observed that in South Africa ostriches may be poisoned by the fruits of *A. venenata*—an interesting fact on the comparative toxicity of fruits of members of the same genus.

Finally, it is important to add that mere drying of leaves, young stems, etc., does not destroy the powerful toxicity of the poison in those parts of the tree. The glucosidal nature of the active principle—acokantherin—is not affected by dessication of the plant.

Treatment of cases of plant poisoning.

In no case of plant poisoning is there any specific treatment. All that can be done is first of all to administer a rapidly acting purgative which may be given hypodermically, e.g. eserine, or in a drench. In the latter case there is nothing better than a full medicinal dose of castor or olive oil, which besides causing increased evacuations from the bowel acts as an emollient or demulcent to the inflamed intestinal

mucosae. Hydrogogue or cathartic purgatives are strongly contra-indicated as are large doses of alcohol or water for the active principles of many plants may be both water and alcohol soluble and consequently the copious administration of these liquids would tend to increase absorption of the poison from the bowel and exacerbate the symptoms.

Nutritive, and at the same time soothing, drinks may be given in the form of pure milk, whipped up eggs and milk, or gruels of various kinds, etc.

When there is great nervous excitement, sedatives, e.g. morphine, should be given hyperdemically, while in cases of nervous depression strychnine is indicated. Other symptoms should be treated as they arise and every effort made to maintain the animal's strength.

After the laxative has had effect the diarrhoea may be controlled by full doses of opium or of the popular chalk and opium mixture. Bismuth preparations, especially the salicylate are regarded by many with special favour. During convalescence the animal should be carefully nursed and at the suitable time given a course of tonic mixtures.

It is well to realise, however, that once symptoms of acute plant poisoning appear there is, as a rule, very little hope of saving the animal.

Prevention of plant poisoning in the domestic animals.

In a continent like Africa, where nature is so generous it is manifestly a problem of the first magnitude to keep the grazing free of poisonous plants. But on farms where there is a serious annual loss from particular species, the only way to control or reduce the mortality is by the constant eradication of the offending plants.

A certain farmer in the Ngong forest area of Nairobi keeps a special gang of natives to cut down *Acokanthera* shrubs as soon as they appear, and the fight promises to be endless. It is only by these energetic measures, however, that the menace can be combatted, and if the mortality is kept low the expense of the native gang is not a serious economic factor.

BIBLIOGRAPHY.

- (1) "Arrow poison." Report of the Chief Veterinary Officer in the Annual Report for 1908-09, Department of Agriculture, British East Africa.

- (2) "Report of the proceedings of the Fifth Pan-African Veterinary Conference." Government Press, Nairobi, 1924.
- (3) "An introduction to the study of poisonous plants of Kenya." R. W. M. Mettam, Veterinary Record, Vol. VLII, Nos. 45 and 46.
- (4) "Preliminary report upon the occurrence of hydrocyanic acid in the grasses of Bechuanaland." 11th and 12th Report of Director of Veterinary Education and Research. Pretoria, 1927; Part I, page 494.
- (5) "Notes on Crotonaria and other leguminous plants." Burtt-Davy. Report of Government Veterinary Bacteriologist. Pretoria, 1909-10.
- (6) "Stiff Sickness in Cattle." A. Theiler.
- (7) "The so-called 'staggers' or pushing disease of cattle in Natal." W. H. Andrews, 9th and 10th Report of Director of Veterinary Education and Research, Pretoria, 1923.
- (8) "Geeldikkop in Sheep." A. Theiler. 7th and 9th Reports of Director of Veterinary Research. Pretoria, 1920.
- (9) "Gousiekte in Sheep." A. Theiler, du Toit and Mitchell. 9th and 10th Report of Director of Veterinary Research, Pretoria, 1923.
- (10) "Vlei Poisoning." A. O. D. Mogg. "South African Journal of Science, 1927." XXIV. Page 269.
- (11) "The toxicity of *Adenia digitata*." Burtt-Davy. H. N. Green and W. H. Andrews, 9th and 10th Report of the Director, Veterinary Education and Research. Pretoria, April, 1923.
- (12) "A preliminary list of the known poisonous plants in South Africa." E. P. Philips. Memo. No. 9, "Botanical Survey of South Africa." Pretoria.
- (13) "Manual of Poisonous Plants." L. H. Pammel. The Torch Press, Cedar Rapids, Iowa.
- (14) "Veterinary Toxicology." G. D. Lander, Bailliere, Tindall and Cox, 1926 edition.
- (15) "Some little known South African poisonous plants and their effects on stock." H. H. Curson, 13th and 14th Report of Director, Veterinary Education and Research, Part I, Pretoria. 1928.

- (16) " Three poisonous plants and their natural enemies in S.W. Africa," Bradfield. " South African Farmers' Weekly." 3rd August, 1927.
- (17) " The toxicity of *Ornithogalum saundersiae*." J. Quin. " South African Journal of Science, 1927," XXIV, page 431.
- (18) " The genera of South African flowering plants," E. P. Philips. " Cape Times," Ltd., Capetown, 1926.
- (19) " A descriptive catalogue of some of the common trees and woody plants of Kenya Colony," E. Battiscombe. Crown Agents for the Colonies, London.
- (20) " Feeding experiments with *Cassia sophera*." H. R. Seddon and H. R. Carnie, Veterinary Research Report No. 2, April, 1926. Department of Agriculture, New South Wales.
- (21) " Pharmacology and Therapeutics of the action of drugs." A. R. Cushny. Churchill, London.
- (22) " The Mexican whorled milkweed (*Asclepias mexicana*) as a poisonous plant." C. Dwight Marsh and A. B. Clawson. United States Department of Agriculture. Bulletin No. 967, 1921.
- (23) " Veterinary Pathology." Vol. I. R. Friedberger and E. Frohner.
- (24) " The common names of the flora of South Africa." Rudolf Marloth. Speciality Press of South Africa, Ltd., Capetown.
- (25) " First footsteps in East Africa." Richard F. Burton. Everyman's Library, 1924.
- (26) For details of experiments carried out by Arnoth and Harries, *see* pages 141, 142, 143 and 144 in Burton's book, cited above.

PUBLICATIONS.

The research work carried out by Officers of the Veterinary Research Laboratory during the year, is recorded in the Annual Report of the Department of Agriculture.

The following papers and articles were also published :—

- (1) " East Coast Fever; artificial immunisation and immunity in their relation to the control of East Coast Fever," by J. Walker and S. H. Whitworth.

- (2) " Rinderpest Research in Kenya," by J. Walker.
- (3) " Pleuro-Pneumonia Contagiosa Bovum," by J. Walker.
- (4) " Memorandum on East African Swine Fever Immunisation," by J. Walker.
- (5) " Vaccination against Rinderpest," by R. Daubney.
- (6) " Memorandum on Horse Sickness Immunisation," by S. H. Whitworth.
- (7) " Contagious Pleuro-Pneumonia of Goats in East Africa," by R. W. M. Mettam.
- (8) " Veterinary Education, with particular reference to State Services in the Tropics," by R. Daubney and R. W. M. Mettam.

The following is in the press :

Revised " Aids to Stockowners."

The Chief Veterinary Research Officer, during vacation leave, attended the Pan-African Agricultural and Veterinary Conference held in Pretoria in August, as one of the delegates from this Colony.

Visitors to the Laboratory included Sir Samuel Wilson, of the Colonial Office, and also a number of the members of the British Association for the advancement of Science.

STAFF.

I wish to record my appreciation of the assistance given by the staff during the year.

APPENDIX E.

ANNUAL REPORT OF THE DIVISION OF
CHEMISTRY FOR THE YEAR 1929.

STAFF CHANGES.

Mr. B. A. Pickering, Junior Laboratory Assistant was transferred to the Clerical Staff at Head Office.

Mr. F. McNaughtan, B.Sc. Edin., was appointed locally as Laboratory Assistant.

Mr. J. W. Phillips was appointed locally as Junior Laboratory Assistant.

A clerical staff consisting of Mr. S. G. Sharp and Mr. A. S. M. Gilfillan has been shared with the Entomological Division since 19th August, 1929.

CORRESPONDENCE.

809 inward and 554 outward letters were dealt with. In addition, 673 reports on analyses were issued.

TRAVELLING.

766 miles were travelled mainly in connection with experimental work. In conjunction with other officers, the Assistant Agricultural Chemist travelled at least another 500 miles in connection with soil work.

The Assistant Agricultural Chemist was away from Nairobi for 26 nights accumulating data in connection with the preliminary soil survey. The Agricultural Chemist was away from Nairobi for 5 nights at the Nakuru Show.

AGRICULTURAL SHOW.

In the dairy class milk tests were performed. Only one animal remained in the class but definitely merited the award. It is very much to be regretted that more interest is not shown in the competition for dairy cows.

Exhibits were staged of soil profiles from various parts of the Colony, and of the conditions of acidity in areas free from and infested by mealy bug, of types of kresotow, of essential oils produced or capable of production in Kenya, and of coffee fermentation.

PUBLICATIONS.

The following bulletins were published during the year.

‘ Preliminary Observations on Some of the Soils of Kenya ’ by D. S. Gracie and G. J. L. Burton (Bulletin No. 4 of 1929).

‘ The Utilisation of Sisal Waste for the Production of Power Alcohol ’ by V. A. Beckley (Bulletin No. 6 of 1929).

‘ Notes on Silt Contents of Some Kenya Rivers ’ by V. A. Beckley (Bulletin No. 7K of 1929).

‘ A Preliminary Note on the Fermentation of Coffee ’ by V. A. Beckley (Bulletin No. 7M of 1929).

‘ Notes on a Preliminary Soil Survey of Some Parts of Kenya Colony ’ by D. S. Gracie (Bulletin No. 7L of 1929).

The last three bulletins were papers read before the Pan-African Agricultural and Veterinary Conference.

In addition, an account was published in the press of the preparation of smoke canisters.

WORK DONE.

Samples received 1,391.

Sample	Outstand- ing at 31-12-28	Received	Examined	Refused	Outstand- ing at 31-12-29
Dips	..	616	600	16	..
Soils	438	459	846	1	50
Manures and Lime	..	22	20	2	..
Toxicological Wireworm ..	..	62	57	5	..
Remedy	..	24	24	..	..
Kresotow ..	..	9	9	..	..
Waters	..	19	19	..	..
Feeding Stuffs ..	..	5	4	..	1
Coffee	..	22	22	..	..
Miscellaneous ..	..	130	129	1	..
Essential Oils ..	..	23	23	..	..
	438	1,391	1,753	25	51

CATTLE DIPS.

There has been a marked increase in the number of cattle dip samples submitted during the year. Very nearly a hundred more than last year have been analysed. Practically all of the samples refused were samples that had been damaged en route.

It is gratifying to report that this year very few samples have been received insufficiently labelled. This is the first year that there has not been a great deal of acrimonious correspondence regarding unlabelled samples of dip wash.

RESULTS OF ANALYSES OF DIP WASHES.

Extent of Error	1926		1927		1928		1929	
	No.	%	No.	%	No.	%	No.	%
Within 1 %	36	6.6	38	5.9	30	5.8	39	6.5
Between 1 % and 5 % ..	89	16.3	119	18.4	81	15.8	98	16.3
Between 5 % and 10 % ..	94	17.2	95	14.7	103	20.1	107	17.8
Between 10 % and 20 % ..	134	24.5	170	26.3	127	24.8	168	28.0
Over 20 %	191	34.9	216	33.5	172	33.5	187	31.4
Too dirty to analyse ..	3	0.5	8	1.2	..	..	..	..
	547		646		513		599	

There has been a slight decrease in the proportion of samples dangerously incorrect. Yet, still about one-third of the samples received represent dip washes which are either ineffective as dip destroying agents or which may injuriously affect the animals passing through them. Quite a number of stockowners regularly maintain their dip washes about 10 per cent above normal strength. Many of the samples lying between the limits of 5 per cent and 20 per cent error are samples from such dips. If allowance were made for this practice, a great improvement in the results would be apparent.

In a few cases, samples of freshly made-up dip washes have been found to be very much below strength. The dip concentrates used in preparing these washes may vary slightly in arsenic content, roughly $\frac{1}{2}$ per cent, but this can never account for these results. In one case investigated it was found that the heavy dip concentrate had been poured into the clean tank and then the water added. The heavy concentrate had not mixed with the water, and remained at the bottom of the tank, covered by an arsenical solution very much under strength. Probably in these other cases the same mistake has been made. The stock being dipped are unprotected

until the strong arsenical solution has been mixed with the weak solution. If more concentrate is added to correct the weak solution, when the strong solution at the bottom of the tank has become mixed, severe scalding of the stock will occur. That it is essential for the directions for use upon the cans of pest remedies to be carefully read and followed cannot be too strongly stressed.

TOXICOLOGICAL.

There has been a considerable increase in the number of samples of ingesta submitted for examination for the presence of arsenic. This increase is only partly ascribable to the locust campaign. There were about twenty-five samples sent in which were definitely in connexion with deaths ascribable to the locust campaign. Reference to these has been made in Bulletin No. 9 of 1929, "History and Activities of Locusts in Kenya, etc.," by Mr. E. Harrison.

It is not clear to what cause the other increase in numbers of samples received can be ascribed.

FEEDING STUFFS.

During the past year a number of stock feeds have been analysed. Insufficient are analysed each year to justify the publication of a bulletin. As the results are of importance to stock-owners, it is intended to publish these in the Annual Reports until sufficient of a varied character have been accumulated to justify the compiling of a pamphlet.

Feed	Moisture	Ash	Crude Protein	Ether Ext	Crude Fibre	Nitrogen free extract
	%	%	%	%	%	%
Simsim Cake ..	10.2	8.0	38.3	14.7	5.6	23.2
Simsim Cake ..	7.6	8.3	38.2	16.7	5.5	23.7
Simsim Cake ..	7.0	8.6	38.3	16.7	5.2	24.2
Simsim Cake ..	10.5	9.4	37.8	15.4	4.3	22.6
Simsim Cake ..	10.1	8.6	34.5	18.7	5.1	22.9
Simsim Cake ..	10.9	9.0	33.4	18.1	5.2	23.4
Groundnut Cake	12.3	4.0	39.5	11.8	4.7	27.7
Couchgrass Hay	9.6	10.8	16.0	1.6	22.7	39.3
Adult locusts dried	6.7	9.0	46.4	17.2	20.7	

The oil content of the oil cakes is very high in every case. There is a likelihood of them becoming rancid on storage. Some of the samples retained in the Laboratory have done so.

The ground-nut cake and one of the samples of simsim cake have remained remarkably sweet; the latter is the sample containing 7.0 per cent of water.

SOILS.

By far the major part of the soil samples have been taken by Mr. Gracie, the Assistant Agricultural Chemist, in the soil investigations upon which he has been concentrating. The preliminary soil survey work has been prosecuted. Some most interesting and valuable generalisations regarding the soils of the Colony have been drawn. Mr. Gracie was occupied in the writing of the bulletin on this work, and so could not prepare a statement for inclusion in the Annual Report, but as this bulletin will very shortly be published, there is no need for a long statement here.

A very interesting relationship between the distribution of mealy-bug and soil conditions has been discovered by Mr. Gracie. Parallel profiles from areas on which mealy-bug were present and absent were sampled and examined. In all cases it was found that where mealy-bug was present the soil was more acid at all levels. Taking the exchangeable calcium as a measure of the saturation of the soil by bases, it is found that, on areas where mealy-bug is present, the soil is much less saturated than on areas where mealy-bug is not present. This indicates a method whereby the incidence of mealy-bug may be controlled. Experiments have been commenced to ascertain whether such control is possible, and when results are available the conclusions will be published, together with the proposed method of soil treatment.

COFFEE MANURIAL EXPERIMENTS AT KASARINI.

Owing to the lateness of the season this year, no results are available. All of the plots are carrying very heavy crops; some phenomenally heavy. Inspection of the plots has shown that in some cases the manurial treatment has not been capable of supplying the needs of the crop. Yellowing of some of the branches was evident; on these there was evidence of the formation of light beans. On cutting transverse section of the immature beans, it was found that one of the beans was not developing properly. The incidence of this etiolation was not regular, but appeared to be most evident on the limed plots.

KRESOTOW.

Many complaints were made during the earlier part of the year regarding the efficacy of the kresotow imported by the Department. In most cases it appeared that the kresotow

in question was all of one consignment which, on examination, both in London and at the Scott Laboratory, had been found to satisfy the specification laid down by Mr. Kirkpatrick. The sample examined in the Laboratory early in the year was normal in appearance. In July, a sample obtained from a coffee planter was brought in by the Senior Coffee Officer. This sample was a thick semi-solid mass. Examination of the reference sample in the Laboratory revealed that this too had solidified. The solidification could only be ascribed to the cold weather at the time. When the sample arrived the weather was hot, and this kept the material liquid.

In use, especially during the cold weather, it was found that this lot of kresotow was an efficient ant repellent for a few days only, after which time ants crossed it freely. The writer was unable to examine bands in this state, but suggests that the reason why the ants were able to cross was that crystallisation occurred on the surface of the band, forming a dry surface over which the ants could cross.

These difficulties with material that really satisfied the specification demonstrated the need for further investigation into the whole subject of the ant repellent. A specification that will ensure the supply of a uniformly satisfactory product had to be evolved. The nature of the material that really repelled the ant had to be determined, if possible, and likely substitutes for coal tar products explored.

As a result of these investigations, a provisional specification for the manufacture of the oil and for the nature of the oil has been drawn up. This will ensure that, from London gas tar at least, a satisfactory product may always be obtained. The possible use of other tars, gas tars from various coals, coke oven tars, etc., is also being explored with the kind aid of Mr. H. J. Page, head of the Research Laboratories of Nitram Limited, at Jealotts Hill Farm.

Various petroleum products have also been studied. Some of these are useless; others last until the oil dries. This has given a clue to the nature of the material which is ant repellent.

As the Department has been able to place the supply of the ant repellent in the hands of a manufacturer of insecticides, who can exercise the control of manufacture, of such a product demands, this firm has been kept informed of all the developments of the investigation. Other firms who have been evincing an interest in the material have also been informed

of developments. Unless something most untoward occurs, no consignment of ant repellent made according to the new specification will be found ineffective.

Corollary to the study of oil, the penetration of grease-proof paper by different coal tar oils and their liquid fractions was also studied. It has been found that certain fractions of the oil have great powers of penetrating grease-proof paper. Certain fractions, under the conditions of the laboratory test, penetrate even the best qualities of grease-proof paper readily; any weak spot is immediately found. The original oil, however, often failed. The conditions of the laboratory test are very much more severe than any that could occur in the field. Although grease-proof paper is not quite uniform and may be easily penetrated at scattered points, it is very much to be doubted if a double thickness of grease-proof paper very carefully applied would show any penetration by the oils at all. Unfortunately, grease-proof paper is rather delicate and when crushed minute cracks are formed through which oil readily passes. This crushing does occur in the field when the bands are applied and penetration occurs. In an experiment at the Scott Laboratories, four layers of grease-proof paper which had been tightly tied over a band of cotton wool were penetrated in ten days along the line of tying. It is the writer's belief that in practically all cases where severe penetration has been recorded, it is due to the crushing of the grease-proof paper in the tying of the oil bands.

It is possible to fix the bands in such a way that no crushing occurs, but it is difficult to make certain that there will be no slipping of the bands. With native labour a simple method must be used; tying appears to be the simplest method, and as long as bands are tied over grease-proof paper there will be a certain amount of penetration. In order to obviate this, some other means of securing protection against the oil was sought. Cellophane meets the needs of the situation. It is not penetrated by the oil, it is very tough, does not crush under even very tight tying—a single layer of cellophane very tightly tied allowed no oil to pass in six weeks—but it is rather more expensive than grease-proof paper. However, when the completeness of the protection afforded is taken into consideration, the extra cost is worth incurring.

A full report of this work will be made the subject of a bulletin.

COFFEE FERMENTATION.

It has previously been recorded that the fermentation of coffee, i.e. the removal of the slimy "saccharine matter" from the parchment of hulled coffee, is due not to the action of bacteria or yeasts, but to an enzyme or ferment in the saccharine matter itself. The nature of the action is such that if one of the products is removed, the rate of change does not decrease. A sugar is produced during the breakdown of the saccharine matter; the removal of this is simple, but products innocuous to the coffee must be produced. Yeast is the most obvious means. A special strain of yeast was developed and found to assist, considerably shortening the time of fermentation and at the same time improving the quality of the liquor.

Apparently this was an end of the matter, but difficulty was experienced in maintaining a strong growth of the yeast. As far as the laboratory was concerned, fermentation with yeast was most successful, but practically there were many difficulties. Several alternatives were considered, but finally it was decided to try the bacteria naturally occurring in fermenting coffee. From the first small lot of coffee ripening in the fly picking of July this year, the species of bacteria predominating was isolated by Mr. Daubney of the Veterinary Research Laboratory.

This bacterium was tested in experimental fermentations at the Scott Laboratory. A considerable saving in the period of fermentation was found; in some cases this was as much as 50 per cent, but the average lay about 33 per cent. The fermented coffee when ready had a cleaner, sweeter smell than the normally fermented coffee. By following the temperature changes it was found that, in the inoculated lot, the action was such as would be produced by one group of bacteria, while, in the normal fermentation, there were several successive bacterial actions. Also, after the mucilage had been removed from the coffee, bacterial action practically ceased when the special strain had been used, but under ordinary conditions bacterial action continued, during which the mass often soured.

Four small samples from the experimental fermentations were sent to Messrs. J. K. Gilliat and Co. They reported a slight improvement in flavour in the inoculated fermented

over the normally fermented coffee in the case of both correctly fermented and over-fermented coffee. From this one may conclude that the products of this bacterial action have no ill effect upon the flavour of coffee.

This method of fermenting coffee, namely the use of a specific organism in sufficient quantity to swamp any chance infection, has manifest advantages. The quality of the coffee may be improved; it will most certainly not be diminished; there is a considerable saving of time; in some cases of more than 50 per cent. In one case recorded, the coffee after inoculation was clean after fifteen hours, while a parallel fermentation under normal conditions required thirty-four hours. The value of this considerable acceleration in times of rush is evident.

A simple means of preparing inoculants for fermentation from tube cultures of the bacteria and of maintaining the strain during picking season has been evolved. This method has been successfully employed by a number of coffee planters throughout the Colony who, after making one or two experimental fermentations, are now using no other method.

The writer is making preparations to meet a heavy demand for cultures of bacteria in the coming year, and hopes to be in a position to supply over 2,000 tubes of culture.

ESSENTIAL OILS.

In the search for some crop, alternative to the staple cereal crops, several farmers have been considering the possibility of producing essential oils. For some time geranium oil has been produced and exported by two planters, and recently cedar wood oil has been exported in fair quantities; in fact, the need for some work upon essential oils was shown by a railway query regarding cedar wood oil.

It appears that there are possibilities in the production of essential oils and that this industry will prove profitable. There is, however, one serious difficulty. The essential oil market is exceedingly conservative, and will not readily offer for a new oil or one from a new source. These preferences have a profound effect upon the price of an oil. There is always the possibility that, after a few years, an oil will establish a niche for itself and command a good price, provided the market is not utterly swamped.

In considering such an industry, as far as possible, oils capable of commanding a high price should be the object in view. There is but little point in growing a crop such as ginger grass unless it is capable of looking after itself; the cost of

weeding will rapidly reduce the profit to the vanishing point. Also, the plant must be suited to climatic conditions. Ylang-ylang will thrive at the Coast, while in the Highlands it will fail. Peppermint will probably do well at places over 8,000 feet, but do poorly at 6,000 feet. At present there is but little information available regarding the climatic requirements of the various essential oil plants capable of being cultivated in Kenya.

During the last half of the year, samples of several plants have been distilled, and in some cases the determinations of the amounts of certain constituents made. Most of these samples have been of geranium, but a number of indigenous and exotic plants have also been examined. The yields obtained are given in tabular form below :—

YIELDS OF ESSENTIAL OILS.

Plant		Source				Oil per cent.
1	Geranium leaves ..	Nairobi	..	Collected early in morning.		0.10
2	Geranium leaves ..	Nairobi	..	Collected at midday, same day as No. 1.		0.18
3	Geranium leaves ..	Nairobi	..	Collected early in morning.		0.09
4	Geranium leaves ..	Njoro	..	..	..	0.20
5	Geranium leaves and stem	Ngong	..	..	..	0.19
6	Patchouli leaves and stems	Scott Agricultural Lab.	..	..	..	0.06
7	Patchouli leaves ..	Scott Agricultural Lab.	..	..	..	0.08
8	Patchouli. Fresh leaves and green stems.	Scott Agricultural Lab.	..	..	..	0.20
9	Patchouli. Fresh leaves, minced	Scott Agricultural Lab.	..	..	..	0.21
10	Patchouli. Fresh leaves fermented and partially dried	Scott Agricultural Lab.	..	..	..	0.13
11	Patchouli. Leaves dried and ground	Scott Agricultural Lab.	..	..	..	0.48
12	<i>Ocimum canum</i> mature	Ngong	..	..	..	0.60
13	<i>Ocimum canum</i> .. young leaves	Kabete	..	..	..	0.15
14	<i>Ocimum canum</i> .. mature	Ngong	..	..	..	0.62
15	Cedar sawdust ..	Uplands	..	..	..	2.6
16	<i>Mentha sylvestris</i> (aquatica?)	Kinangop	..	..	..	0.4
17	<i>Mentha viridis</i> ..	Nyeri	..	..	..	0.1
18	<i>Eucalyptus citriodora</i> leaves ..	Scott Agricultural Lab.	..	..	..	1.1

A number of the geranium oils, as well as some samples of oil produced in the Colony, were analysed for ester content. The lowest value obtained was 8.1 per cent, while the highest was 10.8 per cent, calculated as geranyl tiglate. These figures are low in comparison with the average elsewhere. Possibly, this low ester content may account for the low price of Kenya or, as it is now known on the market, Mawah geranium oil.

The low yields obtained by the distillation of patchouli (*Pogostemon patchouli*), Nos. 8 and 9, grown at the Scott Laboratories, were most disappointing. The plant grows luxuriantly, the oil commands a fair price, so it appeared a most suitable plant for certain areas. Mr. Dawson, of Njoro, most kindly supplied the writer with data of some experiments on the distillation of patchouli in Java. These experiments were repeated here. Fresh leaves were steam distilled after being well packed into the still; when the oil ceased to pass over, the pulpy mass was removed, water drained off, and the mass crushed. This was returned to the still, and a second distillation made. A quite satisfying yield of 0.20 per cent was obtained. Another lot was minced before the first distillation; a slightly higher yield of 0.21 per cent was obtained. The slight increase did not justify the labour involved in mincing. A third lot of fresh leafy material was tightly packed in a glass vessel and allowed to ferment. The leaves were reduced to a pulpy mass, but the yield of oil was disappointing, being only 0.13 per cent. A fourth lot of leafy material was dried in the sun. When dry the leaves were roughly crushed and subjected to two steam distillations. A most satisfying yield of 0.48 per cent was obtained. Probably with high pressure steam and distilling economically, a commercial yield of 0.45 per cent would be possible.

Ocimum canum is a common weed on shallow soil liable to waterlogging. It is very widely distributed in the Colony. Mature leafy twigs give a yield of 0.6 per cent of a camphor-containing oil when completely distilled. The camphor, however, distils over first. On cooling a quantity of this oil, about 12 per cent of solid white camphor was obtained. Very probably by altering the method of distillation and using a suitable condenser, a larger yield of camphor might be obtained by direct distillation, if care be taken not to carry over the oil. Some other *Ocimum* species which are very common are under observation.

Cedar oil is a very attractive proposition. It is obtained from the waste of the sawmills, and by a suitable procedure the exhausted sawdust could be used as the fuel for steam-raising. The high yield is also very attractive. Unfortunately, this oil is not well known on the market, but probably in time a demand will arise.

The two species of mint are both wild mints. The *Mentha sylvestris* yields 0.4 per cent of a clear colourless oil having a very pleasant peppermint flavour. This oil, the writer believes, will readily enter the essential oil market, and probably command a good price. As soon as sufficient material is obtained, a sample will be sent to the Imperial Institute for trial. It is possible that the identification of this mint with *Mentha sylvestris* may be incorrect. The genus *Mentha* was described in the *Flora of Tropical Africa* many years ago. From the characteristics of the oil, the species may be *Mentha aquatica*, which is not described in the *Flora of Tropical Africa* but which does occur in Kenya. The other mint, believed to be a variety of *Mentha viridis*, probably an escape from cultivation, gave only 0.1 per cent of an oil closely resembling spearmint. Probably the low yield was due to a certain amount of fermentation occurring in the herb during transport. It is hoped to obtain fresher material for distillation in the near future.

The yield of oil from *Eucalyptus citriodora* is most gratifying. One authority quotes for Australian material a yield of roughly 0.6 per cent. As *Eucalyptus citriodora* grows very readily in many parts of the Colony, and does command a fair price, it is very promising indeed.

There is one point in connexion with the distillation of essential oils which is worthy of consideration. Organic manures are essential for the maintenance of fertility. In most cases the cost of collection of waste material and the difficulty of the wetting of the heap precludes farmers from making artificial farmyard manure or composts. Practically all the material used for the production of essential oils consists of leafy matter. The residue left after the steam distillation contains all the plant nutrients originally present, is saturated with water, and is in a condition suitable for building into a compost heap. Provided the fact that the material, on removal from the still, is sterile is not overlooked, and soil is scattered over each successive layer to provide the necessary bacteria to cause the decomposition, a valuable manure may be obtained from the residue at a very low cost indeed.

SISAL.

The investigation into the possibility of utilising sisal waste in the production of power alcohol was completed early in the year. Encouraging as did the prospect appear of using sisal waste profitably, the average sugar content was too low to allow of this. The results of the investigation have been reported in Bulletin No. 6 of 1929.

It has been stated that in Java sisal fibre is bleached as produced by a secret process. This bleached fibre commands a higher price than ordinary fibre. At the request of some sisal growers, the possibility of bleaching fibre cheaply in Kenya was investigated. It was found possible, on the laboratory scale, to do this by means of a chlorine bath, both cheaply and quickly, without any apparent loss of tensile strength by the fibre. On the large scale, difficulties, both chemical and engineering, would be encountered, but there is no doubt in the writer's mind that, if the need arose, these would readily be overcome. So far, however, it appears that the need for the bleaching of Kenya fibre has not yet arisen.

SMOKE SCREENS.

The use of smoke as a means of preventing flying locusts from settling is an accepted means. There is the difficulty of obtaining sufficient fuel to produce good smudge fires at the required places. It was realised that some cheap means of producing a smoke screen pyrotechnically would be demanded. Many attempts were made to produce such a mixture without success; incidentally, it may be mentioned that some of the mixtures produced were distinctly dangerous.

Recently, at the desire of the Deputy Director of Agriculture, the matter was reopened. It was found that the reason for failure was a non-appreciation of pyrotechnic principles. After quite a few trials, a very successful means of producing a heavy smoke screen was evolved. This involves the use of two mixtures, and although this may seem complicated, it is really very simple to prepare.

Two mixtures are employed, one constituting the main charge which burns slowly and is difficult to ignite, the other, which burns fairly fast, in the form of cores to ignite and keep the main charge burning.

The main charge has the following composition :—

Saltpetre (nitrate of potash) ...	10 lb.
Sulphur	1½ lb.
Sawdust	7½ lb.
Coal tar oil	12½ lb.

The core charge has the following composition :—

Saltpetre	...	...	...	4 lb.
Sulphur	...	...	...	1½ lb.
Sawdust	...	...	...	1½ lb.
Coal tar oil	...	...	...	3 lb.

(By coal tar oil is meant any liquid coal tar product, such as creosote, etc.)

The sulphur and saltpetre, which must be finely ground, are first well mixed, and then the sawdust added. When this has been mixed in, the coal tar oil is poured in, and the mass stirred until all the oil has been absorbed. Care must be taken in the mixing not to use tools that might produce a spark, especially with the dry materials, as otherwise the mass may ignite and cause a fire.

As in burning a great deal of heat is evolved, fairly heavy cans should be used for the large charges. Small canisters may be made in any can which usually may be used two or three times. On the whole the large canisters, which may be carried about by means of a wire handle through which a pole is thrust, are the most satisfactory in use.

In filling the cans, a layer of the main charge about 1 in. thick is poured into the can and well rammed with a wooden rammer. Smooth wooden rods, 2 in. to 3 in. in diameter, are placed upright on this layer to form the core channels; a small canister requires one core only, while a four-gallon drum requires four or five cores. The main charge is now poured in in small quantities, and rammed down firmly, taking care that the material is well compacted around the rods. The can is filled to a few inches from the top. The wooden rods are removed one at a time, the channels filled with the core charge mixture, which is also well compacted. These charges are ignited by means of a rag dipped in petrol or of igniters made by soaking strips of cardboard in a strong solution of saltpetre and drying them.

ENTOMOLOGICAL.

(a) Artificial Feeding of Ladybirds.

In the breeding of ladybirds it appears that a difficulty in providing sufficient mealy-bug is encountered, and that there is a need for some artificial food which can be readily prepared. Preliminary experiments were conducted on these lines with Mr. Kirkpatrick some years ago, with but little success. At the request of the Entomologist, the matter has been reopened.

An ordinary chemical analysis of mealy-bug is of very little value. Not the whole of the creature is eaten. The labour involved in the dissection of the large numbers of mealy-bug necessary to obtain sufficient material for analysis would be impossible to undertake. The evolution of a suitable food becomes a case of empirical trial and error. Use was made of the formula originally evolved, and which was eaten. Certain changes have been made, one after the other, without any marked success. A food has been prepared which the ladybirds will eat but, when fed in a clean cage, without zest.

When, however, the food is given to the ladybirds in cages that have contained mealy-bug, they eat the present food. Is there a need for the food to have a flavour of mealy-bug or some such insect? Experiments on these lines are being conducted.

(b) *Insecticides.*

There is still a certain demand for insecticidal sprays in the Colony. Some attention has been given to these. A method of obtaining a very complete dispersion of pyrethrum has been devised and is awaiting field trial.

One of the local fish poisons, *Barringtonia racemosa*, is also under experiment. No record of this material being used as an insecticide can be found. Spray mixtures containing this have been prepared and these two are awaiting field trial.

V. A. BECKLEY,
Agricultural Chemist.

APPENDIX F.

ANNUAL REPORT
OF THE SENIOR ENTOMOLOGIST, 1929.

STAFF.

The following officers constitute the staff of the Entomological Section of the Department of Agriculture :—

T. J. Anderson, M.A., B.Sc. (Edin.), F.Z.S., F.E.S.,
Senior Entomologist ;

H. Wilkinson, A.R.C.Sc., F.E.S., F.L.S., Entomologist ;

H. C. James, Ph.D., B.Sc., N.D.A., N.D.D., Entomologist ;

R. H. Le Pelley, Ph.D., B.Sc., A.R.C.Sc., D.I.C.,
F.E.S., Entomologist ;

T. L. McClelland, M.C., Insectaries Manager.

S. G. Sharp, Grade A Clerk ;

A. S. M. Gilfillan, Laboratory Learner.

The native staff numbers twenty.

Mr. Anderson arrived at Mombasa, on his return from leave, on the 2nd January.

Mr. Wilkinson left, on leave, on the 23rd February, and returned on the 30th September.

Dr. Le Pelley arrived, on first appointment, on the 22nd May.

Mr. McClelland was appointed locally on the 1st August.

Mr. Sharp was appointed locally on the 19th August.

The distribution of the staff is as follows :—

The Senior Entomologist, the Insectaries Manager, and the Clerical Staff are stationed at the Scott Agricultural Laboratories. Mr. Wilkinson is stationed at Nakuru, and is in charge of investigations into insect pests of maize, wheat, barley, etc. Dr. James, in the Thika-Donyo Sabuk area, and Dr. Le Pelley, in the Kiambu-Limuru area, are almost entirely engaged in work connected with the coffee mealy-bug and its control.

TRAVELLING.

9,864 miles were travelled by the staff by car on Government service :—

T. J. Anderson	...	...	...	2,344
H. Wilkinson	...	...	...	1,512
H. C. James	...	...	...	3,960
R. H. Le Pelley	...	...	...	2,048

CORRESPONDENCE.

2,550 letters were dealt with. The subjects are summarised as follows :—

Bees and wax	...	...	...	5
Citrus	...	...	...	14
Coffee	...	...	...	1,248
Cotton	...	...	...	19
Flowers	...	...	...	8
Fruit and fruit trees	...	...	...	31
General	...	...	...	254
Import and export of plants	...	...	...	280
Library, books, periodicals	...	...	...	48
Locusts	...	...	...	58
Maize	...	...	...	66
Miscellaneous insects	...	...	...	56
Sericulture	...	...	...	26
Sisal	...	...	...	14
Staff	...	...	...	168
Sugar cane	...	...	...	4
Tea	...	...	...	
Trees, shade and forest	...	...	...	21
Upkeep of laboratories and insectaries	...	...	...	182
Vegetables	...	...	...	22
Wheat, barley, etc.	...	...	...	20
				2,550

ROUTINE.

782 specimens of insects, damaged plants and seeds have been examined and reported on.

250 applications for permits to import plants have been scrutinised, amended or approved.

481 parcels of bulbs, vegetable and flower seeds, potatoes and fruit trees have been imported during the year.

21 consignments for export have been examined and certificates given. These have consisted of sisal bulbils, tobacco seed, coffee seed, fruit trees.

An exhibit was prepared and staged at the Nakuru Agricultural Show.

Two meetings of the Coffee Planters' Union were attended.

Evidence was given before the Agricultural Commission.

VISITORS TO THE LABORATORIES.

During the year we have had 344 visitors, and it is gratifying that most of these have been settlers, who are beginning to find that ten minutes' explanation and demonstration is more valuable to them than pages of correspondence.

Distinguished visitors have included : His Excellency the Governor, Sir Jacob Barth (Acting Governor), the Colonial Secretary, Sir Samuel Wilson, Dr. G. A. K. Marshall (Director of the Imperial Bureau of Entomology), Sir Robert Greig, Sir Daniel Hall, and other members of the British Association who visited the Colony; Members of the Legislative Council.

PUBLICATIONS.

1. " Biological Control in Kenya, with Special Reference to the Problem of the Common Coffee Mealy-bug, *Pseudococcus lilacinus*, Ckll." (Communicated to the Pan-African Agricultural and Veterinary Conference, Pretoria, August, 1929.)—Dr. James.

2. " The Control of Maize Stalk Borers."—T. J. Anderson. (Communicated to the Pan-African Agricultural and Veterinary Conference, Pretoria, August, 1929.)

3. " Methods for the Biological Control of the Common Coffee Mealy-bug."—Dr. James. (Published in the *East African Standard* and in the *Times of East Africa*.)

4. " Banding for the Control of the Mealy-bug Ants of Kenya."—Dr. James. (Published in the *East African Standard* and in the *Times of East Africa*.)

5. Lecture on " The Common Coffee Mealy-bug, *Pseudococcus lilacinus*, Ckll., and its association with the Ant, *Pheidole punctulata*, Mayr."—Dr. James. (Reprinted from the *East African Standard* and issued as a pamphlet to members of the Ruiru Farmers' Association.)

LECTURES.

Dr. James delivered two lectures, one at Ruiru and the other at Thika, on the coffee mealy-bug.

The more important insects of economic importance, dealt with under the headings of the crops which they attack :—

COFFEE.

During the year under review nearly half of the correspondence and more than half of the routine work of the section has dealt directly with the coffee industry, more especially in connexion with the ecology of the coffee mealy-bug and measures to be taken for its control.

Both Dr. James and Dr. Le Pelley have been engaged in this work, and Dr. James reports as follows :—

Species of Mealy-bug.

" *Pseudococcus lilacinus*, Ckll., continues to be the most economically important species of mealy-bug at present found on coffee in Kenya, although the difficulty of distinguishing *Pseudococcus lilacinus*, Ckll., from *Pseudococcus comstocki*, Kuw., in the field may mean that the latter is more common than is generally suspected. *Icerya nigroareolata*, Newst., a scale not unlike mealy-bug in appearance, and sometimes mistaken by planters for the latter, produced a light but rather widespread infestation on a plantation in Ruiru. The scale was attended, apparently exclusively, by the ant *Acantholepis capensis*, Mayr., and but little damage appears to have been sustained.

No further cases of infestation of coffee trees by the root mealy-bug have come under my observation.

Species of Mealy-bug Ants.

Numerous observations have led me to the conclusion that the principal ants attending *Pseudococcus lilacinus* belong to the genus *Pheidole*, of which *Pheidole punctulata*, Mayr., is almost certainly the most important.

Acantholepis capensis, Mayr., although not infrequently met with, does not appear to be capable of supporting such intensive infestations of *Pseudococcus lilacinus* as those attended by species of *Pheidole*.

A large species of black ant, not yet determined, was observed to pass easily and swiftly over kresotow bands which were effective against *Pheidole*, but, fortunately, their objective did not appear to be mealy-bug.

During my study of species of *Pheidole*, an undetermined Paussid beetle was usually found in close association with the ants.

Where an intensive infestation of mealy-bug occurs, which is apparently unattended by ants, the advice of an entomologist should be sought before control measures are decided upon.

Ant Control.

The prolificness and omnivorousness of the *Pheidole* ants render destructive measures extremely difficult. Hence, work on ant control still takes the form of attempting to perfect some kind of repellent band. Field experiments are being conducted in conjunction with the Agricultural Chemist, with a view to improving the specification for kresotow, or finding a more efficient substitute.

It has been found that the chief point of penetration of the grease-proof paper by the kresotow is along the line of tying.

A substance, familiar as the transparent wrapping of chocolates, and technically known as 'cellophane,' promises to provide a very satisfactory substitute for grease-proof paper. It is less liable to variations of quality than is grease-proof paper, and the certainty of adequate protection being afforded the trees would be well worth the slightly higher cost of cellophane.

Adhesives.

If, for some reason, it is considered necessary to use adhesives for ant stopping purposes, the following warning is issued: No matter how great the temptation, from the point of view of ease of application and cheapness, *do not apply adhesives direct to the bark of coffee trees*. Such a measure may be largely successful in saving crop, but the ultimate result to trees so treated is very likely to be disastrous. I should also like to warn planters who have applied adhesives in the above manner to refrain from directing natives to manipulate the grease with their hands in order to restore the stickiness of the surface, because the bark beneath the grease is usually reduced to a soft pulpy condition, and many trees will be immediately ring-barked by such treatment. In fact, it is

almost impossible to remove the substance from the trees by scraping the bark owing to the danger of ring-barking. Hence the grease should be carefully dissolved off with a mixture of petrol and methylated spirit, and the bark built up again with a weatherproof linewash.

Concerning the use of adhesives on bands of various kinds, they should be regarded as a last resort, owing to the danger, especially if their use becomes at all widespread, of bringing about results inimical to efficient biological control.

Banding.

It would probably assist some planters to band more effectively against the attendant ants of mealy-bug if they obtained a firm grasp of the principles underlying the process.

The factor which has most to do with the rapid increase of *Pseudococcus lilacinus* at certain seasons of the year is undoubtedly the nature of its food. The rich sap, elaborated for the development of the flowers and young fruit, when imbibed by *Pseudococcus lilacinus* has a specially stimulating effect on its reproductive powers. Therefore, when this species of mealy-bug is present on coffee trees, attended by species of *Pheidole*, when flowering occurs a rapid increase in its numbers is almost assured. *Hence coffee trees, in mealy-bug areas, must always be banded before the 'spike,' for important flowerings, has formed.* This may be described as the ideal time to band, and planters must attempt to get as near this ideal as practical conditions will allow.

Whilst the date of banding will vary with the local conditions, and banding is sometimes postponed owing to the exigencies of other operations, it must be remembered that if primaries are allowed to become white with mealy-bug, almost the entire crop will be lost, no matter how efficiently the banding is then performed.

One of the most important points about which reliable information is desired is the effect of continuous banding on mature trees.

The writer has laid down experiments which he hopes will give us some information on this important point. Naturally, however, it will take several years to gain certain knowledge. The lack of this certain knowledge divides those who are actively thinking about the problem into two schools. First, there are those who do not believe that continuous banding will harm mature trees. Presupposing that their opinion with

respect to possible damage to trees is correct, their only difficulty will be to secure the efficiency of the bands at the all-important times.

Bands tend to break down unevenly over the banded area, and it is very important that all the bands should be examined immediately before the critical flowering period arrives. It is doubtful whether permanent banding results in much saving of labour costs. There are, however, certain planters whose flowerings occur spread over a considerable part of the year who are risking permanent banding in order to solve labour and management difficulties.

Where permanent banding is adopted, I would suggest that when bands are renewed their positions on the trunks should be altered where possible. Permanent banding is probably the only system applicable to stumped coffee, but if it is applied to young coffee great care and supervision will be necessary.

Secondly, there are those who believe in removing the bands as soon as the crop which they have safeguarded is beyond the reach of mealy-bug attack. This method requires more intelligence for its efficient working, but it is certainly a very safe and feasible arrangement on those plantations where there is only one fairly short important flowering period per annum. On plantations where this method is pursued, areas known to be infested should be banded before the 'spike' has formed. Areas which have been clean hitherto should be carefully inspected about this time, and if mealy-bug is found in small clusters on the small growth, such as the growing points of suckers, in the crevices of the old bark or at the base of the flowering buds, banding operations should be performed without delay, especially if their presence is associated, as it usually is, with ant activity. Do not vacillate in the hope of saving banding expenditure because superficially the trees appear to be in a healthy and clean condition. With the advent of the flowering the infestation will become widespread, and it is then very doubtful whether banding will save much crop although it may enable the trees to be reconditioned more quickly for the following season. Hence money which is spent on belated banding operations is largely wasted. After the clean-up has occurred on efficiently banded areas and the cherries are well on the way to maturity, the bands may be removed without risk of loss of crop.

Preventive Pruning.

The quiescent period of *Pseudococcus lilacinus* usually coincides with the colder season of the year, and the absence of young growth, especially the flowers and very young berries. Towards the end of the quiescent period a great many foci of general infestation may be destroyed by judicious pruning, especially of infested suckers. The infested prunings should be collected into large bundles and allowed to remain in the plantation to give the predators present an opportunity of maturing and becoming useful again. When large numbers of mealy-bug are observed in the crevices of the old bark below the level of the bands, an application of limewash will also be very efficacious in reducing their numbers.

Soil Conditions and the Incidence of Pseudococcus lilacinus.

From continuous observations, I am convinced that humus is the soil component which has the greatest influence on the incidence of mealy-bug. Although soils with a high percentage of organic matter usually have a high ant content, it is found that where the ants are efficiently controlled the speed with which trees recover from mealy-bug attack is largely determined by the amount of organic matter in the soil. The greater the amount of humus in the soil the greater will be the water-holding capacity, and the larger the amount of available nitrogen. Hence trees growing in such soils refurnish themselves with new leaves and bearing wood with correspondingly greater rapidity. The practice of green manuring for the maintenance of the humic content of soils presents certain difficulties on mealy-bugged plantations from the necessity of avoiding contacts on banded areas and from the fact that *Pseudococcus lilacinus* is very partial to certain plants which may be used for green manuring, especially those belonging to the Leguminosæ.

Since sufficient supplies of cattle and goat manure are becoming more difficult and more expensive to obtain, the practice known as 'ground thatching,' which is a cheap and valuable method of increasing the organic matter in the soils of coffee plantations, deserves to be better known.

This practice consists of cutting grass and other vegetation, from the veldt or other land, and covering the plantation between the rows with it. The vegetation should be cut so low as to obtain part of the roots. The best time to ground

thatch would probably be just prior to the rains, and the vegetation should be partially covered with soil to assist decomposition and to obviate the risk of fire.

Ground thatching, apart from its value as a source of humus, may be made to serve the following purposes :—

1. If the rows of vegetation are placed anti-washwise on slopes they will materially assist in preventing erosion.
2. Besides increasing the water-holding power of the soil ground thatching tends to prevent surface evaporation. It is well known that a given area under crops causes a greater loss of water than the same area under a bare fallow.
3. Ground thatching hinders the growth of weeds, which is a specially important consideration on mealy-bugged plantations.

The making of compost heaps of cherry pulp and all other available kinds of animal and vegetable matter should not be neglected as sources of humus and it should be remembered that the addition of ' Adco ' to such accumulations will greatly improve their manurial quality.

Concentration of the Flowering Period.

It should certainly be better known than it is that the optimum conditions for mealy-bug development—conditions which result in the greatest devastation—are a series of flowerings at relatively short periods. I suggest to planters therefore that consideration should be given to the desirability of devising methods of pruning which will tend to have the effect of concentrating the flowerings into one short period or periods in the year.

Biological Control.

Ant control is still the first and, in the present state of our knowledge, the most important step in the biological control measures applicable to the common coffee mealy-bug. Given efficient ant control, at the proper time, the amount of crop saved will vary in practice with the kind and number of the predators present in the infested plantations and the celerity with which others arrive.

In view of the fact that this type of control had hitherto proved the most successful, the writer, on beginning mealy-bug research early in the year, decided to begin a detailed study of the predators and parasites of *Pseudococcus lilacinus*,

more especially to determine their relative degree of effectiveness and the ecological conditions which favoured or retarded their increase and dissemination in the field. From research of this nature it is hoped to devise the most effective means of increasing the efficiency of predatory and parasitic action.

In a bulletin entitled, "Methods for the Biological Control of the Common Coffee Mealy-bug," which has been published in the local Press, the writer describes the methods which may at present be employed for the conservation and increase of mealy-bug predators.

Apart from ant control, which has already been dealt with, these are :—

1. The breeding in private or public insectaries of imported and indigenous predators.
2. The re-distribution of predators on partially infested plantations.
3. The collection and storage of certain species of predators with a view to their liberation at the appropriate time.

Each of these methods will be again considered in its relevant place in this report in the light of more recent work.

Factors Influencing the Rapidity of Biological Control.

The speed with which the predators of *Pseudococcus lilacinus* are able to control the latter is of such economic importance that a consideration of the factors influencing the course of events will help to focus attention on the essential issues. Leaving out of account the parasites of mealy-bug, all of which are of no practical importance and may safely be neglected, the factors which decide how soon mealy-bug will be controlled by its predators are :—

1. The initial mealy-bug population.
2. The effective reproductive rate of the mealy-bug.
3. The effective reproductive rate of the effective predators.
4. The presence or absence of effective enemies of predators.
5. The dietary specificity of the effective predators.
6. Climatic conditions.
7. The initial effective predator population.

The Initial Mealybug Population.

The importance of the number of mealy-bugs on an infested area previous to the seasonal epidemics is obvious. The only economically practicable measures which might be taken to reduce the initial mealy-bug population, prior to an epidemic, would be the preventive pruning and de-suckering methods and the limewashing of the tree trunks already discussed. The introduction of predators at this stage could not be expected to improve matters much because this pest residuum has already survived the clean-up of the previous epidemic at the close of which a large predator population had been cannibalising each other for the apparent lack of more suitable food.

Under the ecological conditions which at present obtain on areas where mealy-bug has become well established, there is no known method of economically exterminating the pest. A certain number will always survive sufficient to start a new epidemic at the next favourable opportunity. *Hence it may be regarded as a rather rare contingency that a plantation banded against mealy-bug will not require the adoption of similar control measures in subsequent seasons.*

The Effective Reproductive Rate of Pseudococcus lilacinus.

With the advent of the very suitable food which the flowering times of the coffee plant afford, the reproductive rate of *Pseudococcus lilacinus* is greatly accelerated, and, for a time at least, probably considerably exceeds that of all its enemies, with the possible exception, on occasion, of Psocids.

The time taken to complete the life cycle of individual mealy-bugs during this optimum period for their development is considerably shortened, and the reproduction is almost entirely parthenogenetic in character.

It cannot be too strongly emphasised that it is during this extremely active breeding phase, mainly induced by the suitability of the food available, that the chief loss from Pseudococcus lilacinus is sustained.

The Effective Reproductive Rate of the Effective Predators.

The reproductive rates of the effective predators vary considerably but, as already stated, they are inferior to that of *Pseudococcus lilacinus* during the latter's active phases. The term 'effective predators' is meant here to include only those predators which are capable, under the conditions prevailing in an infested area, of increasing their numbers in some useful ratio with the increase of mealy-bug.

The Presence or Absence of Effective Enemies of the Effective Parasites.

On areas where ants have been effectively controlled, it can with certainty be stated that by far the most important enemies of the predators of *Pseudococcus lilacinus* have been eliminated. Parasites and predators on the effective predators of the mealy-bug which are capable, in some cases, of playing an important part will be discussed later.

The Dietary Specificity of the Effective Predators.

Although certain of the most effective predators of *Pseudococcus lilacinus* will feed on other species of mealy-bug, various scales and aphids which may be present in coffee plantations, it is only very rarely that this factor becomes one of practical importance. In fact, the presence of an alternative diet for the predators is sometimes useful in assisting the latter to tide over the periods of mealy-bug scarcity.

Climate and other Environmental Factors.

The climate and other environmental conditions which normally favour an epidemic of *Pseudococcus lilacinus* are generally sufficiently favourable for the development of the most important predators of the coffee mealy-bug. Climatic conditions adverse to the development of mealy-bug, such as a prolonged rainy period accompanied by lowered temperature, do not affect the best predatory ladybirds as unfavourably as their host.

The Initial Effective Predator Population.

It is of course obvious that the greater the initial population of the effective species of predators, i.e. those predators capable under all the conditions prevailing of increasing their numbers in an economically important ratio with the increase of mealy-bug, the quicker will control be achieved. Hence the question naturally arises: Can certain of the best species of indigenous predators be forced quickly into dominance by large increases of their numbers at the beginning of the active breeding phase of *Pseudococcus lilacinus*? The two methods by which this desideratum might be effected are:—

1. Storage of large numbers of the best species of predators from the previous 'clean-up.'
2. Breeding the desired species in insectaries.

Concerning the liberation of predatory insects for the control of coffee mealy-bug, it cannot be too strongly emphasised that the time factor is all-important. If liberations are

made too early the insects either die of starvation, cannibalise each other, or migrate. If liberations are made too late, most of the flowers and young berries will have been destroyed, and any kind of crop-saving control at such a stage is useless.

The best time to liberate predators on infested plantations is at the beginning of the active breeding phase of Pseudococcus lilacinus.

Predators of Major Importance.

The indigenous species of predators which are undoubtedly of major importance are :—

Coccinellidæ—

Chilocorus angolensis, Crotch.

Hyperaspis delicatula, Muls.

Hyperaspis senegalensis, Muls.

Hyperaspis sp.

Scymnus guttulatus, Sic.

Scymnus spp.

Agromyzidæ—

Leucopis africana, Mall.

These species have a practically general distribution throughout the mealy-bug infested areas and, where efficient ant control is obtained, the chief limiting factor to their increase is the quantity of *Pseudococcus lilacinus* available. Hence it is of paramount importance that efforts should be made to ensure if possible a predominance of one or more of these species at the appropriate time.

Chilocorus angolensis, Crotch.—This species of ladybird is probably the best known predator of *Pseudococcus lilacinus*. It is probably sufficient to remind the planter that it is a large, very convex, shining black species, about a quarter of an inch in length. What specially distinguishes each adult is the presence of an oval red spot near the extreme tip of each wing case. The adult insect is pale yellow when it emerges from the pupa, but turns black within about two hours. The most interesting and important fact discovered about *Chilocorus angolensis* this year is that breeding is definitely seasonal. During a variable period of the year, which begins usually in July and which terminates usually in November, it is difficult if not impossible to find the larvæ in certain mealy-bug districts.

It might be urged that the great decrease in the prevalence of mealy-bug which occurs about this time in some districts is responsible for the absence of larvæ and not an inherent indisposition to breed. Among the small clusters of mealy-bug, however, which may be found during this period on coffee trees, larvæ of *Hyperaspis*, *Scymnus* and *Leucopis* may frequently be detected, but the writer was never able to observe the larvæ of *Chilocorus* at such times and in such situations. Generally in November, many pairs of *Chilocorus* may be observed *in coitu* and careful search later will reveal on leaves or green stems little, irregular heaps of lemon-coloured, somewhat spindle-shaped eggs, which turn black immediately before the larvæ hatch. From November onwards they increase in prevalence progressively with the increase of mealy-bug, and the number of their adults is greatest when the latter is on the decline.

With the great decrease in mealy-bug which eventually takes place, a great amount of cannibalism occurs among the larvæ and a large number of the adults migrate from the plantation. This is a time when a certain amount of collection and storage of adults would be useful with a view to their liberation at the commencement of the next epidemic. The type of storage insectary required has already been described in the Departmental Bulletin on Biological Control. In practice it has been found advisable to have the door of the storage insectary on the more shaded side, otherwise trouble will be experienced owing to most of the ladybirds being attracted to the chief source of light, and loss will be greater from escape and injury. Water should be given to the ladybirds in the form of a thin film spread over a sheet of glass or other smooth surface, and the supply should be frequently renewed.

Where mealy-bug is not available, artificial food should be given, which should be spread out in a thin layer on a suitable platter.

On ant-controlled areas, *Chilocorus angolensis* has no enemy sufficiently numerous to be of economic importance. Species of predaceous Reduviids prey on them, their larvæ are recorded as having been devoured by species of Chrysopids (Lacewing larvæ), but the losses from such sources cannot normally be great.

It is also practically certain that *Chilocorus angolensis* has no internal parasite which is at all numerous, otherwise it would have been observed before now.

Chilocorus angolensis is one of the most polyphagous ladybirds which prey on *Pseudococcus lilacinus*. Besides *lilacinus*, it has been observed to feed on other species of mealy-bug, scales and aphids. This somewhat varied dietary is helpful rather than harmful from the standpoint of mealy-bug control because on areas where *Pseudococcus lilacinus* is numerous the other pests on which *Chilocorus angolensis* feeds are seldom in sufficient numbers to interfere with the efficiency of this ladybird as a predator on *Pseudococcus lilacinus*.

Hyperaspis delicatula, Muls.—Although individual adults and larvæ of this species do not account for so many mealy-bugs as *Chilocorus angolensis*, they are usually more numerous. *Hyperaspis delicatula* probably ranks with *Chilocorus angolensis* as the most important predators of *Pseudococcus lilacinus*. Its most important enemies are species of Pheidole ants which are responsible for a high mortality among the larvæ due, no doubt, to the fact that the latter are usually to be found buried in the mealy-bug clusters, and thus fall an easy prey to the ants. *Hyperaspis delicatula* would prove adaptable for storage purposes because, although it is not seasonal in the same manner as is *Chilocorus angolensis*, storage of the adults at the end of the clean-up would result in a much larger effective breeding population at the beginning of the next epidemic.

Hyperaspis senegalensis, Muls.—This is a larger species than *Hyperaspis delicatula*, and is seldom so abundant as the latter on ant-controlled areas, partly on account of the fact that it is often parasitised by an internal Hymenopteron, *Xenocrepis secundus*, Cwfd. It is probably this factor which prevents it being as effective as the two species already discussed. It is, nevertheless, a very important predator and is entitled to the first rank of importance.

Species of *Scymnus*, including *Scymnus guttulatus*, Sic.—These are small but highly numerous species of ladybirds whose distribution throughout the mealy-bug areas is general. Both adults and larvæ are very active feeders and breed without intermission throughout the year. They have no important enemies on ant-controlled areas, but their small size increases the difficulties of the technique either for breeding or storage purposes. It is hoped that success with the more sizable species, already referred to, will render attempts to breed them unnecessary.

Leucopis africana, Mall.—This predator, which is the larva of a small black Agromyzid fly, lies buried in the clusters of mealy-bugs in a similar manner to the larva of *Hyperaspis*

delicatula. The larvæ of *Leucopis* is infested by an internal hymenopterous parasite whose incidence is sometimes so important as to affect seriously the value of *Leucopis africana* as a predator of *Pseudococcus lilacinus*. The breeding of this predator in insectaries would present considerable technical difficulties.

Predators of Secondary Importance.

With the occasional exception of certain species of Psocids, the following predators seem to be incapable, alone, of destroying an infestation of mealy-bug, and at the best are only useful auxiliaries.

Species of Psocidæ.

Many species of Psocids prey on the common coffee mealy-bug, but their incidence in coffee plantations is so erratic, albeit occasionally so extremely effective, that they hold a somewhat unique position among the predators of mealy-bug. The climatic condition which seems best to favour their development is cool dry weather. Rain, especially, is very inimical to their welfare. Efforts are being made to discover the cause or causes why Psocids so frequently fail to develop their maximum degree of effectiveness.

Effochomus nigromaculatus, Goeze.

Judging from the records, this species of ladybird has become much more numerous on mealy-bug infested plantations, and has now spread to the Ruiru district, from which it had not previously been recorded, and is now a factor of some importance. This is a species which it may pay to breed since there does not appear to be any important natural impediment to its increase provided the supply of *Pseudococcus lilacinus* is sufficient.

Chrysopa sp. (Green Lacewing Flies).

The larvæ of only two species are known to feed on *Pseudococcus lilacinus*. Their distribution appears to have become more general during the last two years, but they are unlikely ever to be more than secondarily important.

Eublemma costimacula, Saalm.

The larva of this moth, although generally distributed, shows no indications of becoming of major importance.

Predators which are of little or no practical value.

Hemerobiids (brown lacewing flies).

Conopterygids.

Coccinellids—

Chilocorus discoidus, Crotch.*Chilomenes lunata*, F.*Chilomenes vicina*, Muls.*Alesia aurora*, Gerst.*Alesia posticalis*, Frm.*Dysis quadrilineata*, Sic.*Platynaspis capicola*, Crotch.*Platynaspis kollori*, Muls.

Syrphids, spp.

These predators, although occasionally found feeding on *Pseudococcus lilacinus*, seem to be incapable of increasing *pro rata* with increases of *Pseudococcus lilacinus*. In many cases their most favoured diet is not *Pseudococcus lilacinus*, but, owing to a dearth of the host on which they thrive best, are compelled to prey on the coffee mealy-bug. Hence it is only where there is a somewhat favourable conjunction of events that any of these predators are likely to be at all helpful. It should also be remembered that if species of predators of major importance are present, their assistance is not indispensable. Artificial attempts to increase their numbers, even if these were practicable, are unlikely to be profitable.

Internal Parasites.

The incidence of the internal parasites of *Pseudococcus lilacinus* is being carefully watched, but as yet it is so small as to be of no practical importance. It can only be hoped that the species of parasites which are sometimes very numerous on the biological strains of *Pseudococcus lilacinus* which do not feed on coffee, will succeed in adapting themselves to the biological race on coffee. This, however, must be a natural process and prolixity cannot be expedited by artificial means. Efforts will be made, where practicable, to introduce effective species of mealy-bug parasites from other countries in the hope of securing their establishment in the Colony.

Imported Species of Ladybirds.

The chief successes effected by biological control in the past have been obtained by the introduction of parasites or predators into areas where their natural enemies were few or absent and their natural increase was controlled mainly by the supply of food material. In such cases the introduced natural enemy of the pest has become firmly established, and

has reduced its host to a position of economic insignificance. In other less ideal conditions imported predators have proved a practicable control provided their numbers were continually augmented at certain seasons of the year by insectary-bred supplies. *Cryptolæmus montrouzieri*, Muls., the so-called Australian mealy-bug destroyer, has again been introduced, and is being 'bred up' in the Departmental Insectaries. Previous experience suggests that it can only become firmly established on plantations where the ants are effectively controlled, and even then its numbers will probably require augmentation at the beginning of each infestation. Whether *Cryptolæmus* will ultimately prove as valuable for breeding purposes as certain of the best indigenous species of ladybirds, experience alone can determine."—*Dr. James.*

Dr. Le Pelley reports as follows:—

"Work was begun in June on the coffee mealy-bug in the Kiambu district. As the utilisation of Coccinellid predators and kresotow banding were already being studied, work was begun chiefly on two lines, which from a general study of the pest in a large number of estates in the district, appeared to require investigation: A study of the attendant ants and their activities, and a preliminary investigation of the utility of spraying in control. Both these aspects are still being studied, and no final conclusions can be recorded. The following notes on the preliminary indications of this work are not to be taken as having any finality.

In the Kiambu district the mealy-bug is attended by at least seven species of ants, which vary in incidence, in numbers, and in importance. On any estate the mealy-bug may be attended by one or more of these ants, and probably the likelihood of the mealy-bug becoming a very serious pest depends largely on the species of ant present.

Pheidole punctulata, Mayr., the species of ant which nearly always accompanies the mealy-bug when it is really serious, is widely spread in Kiambu and Limuru, but on some estates it does not exist. Where it does not exist the mealy-bug may be attended by *Acantholepis* sp., which is the ant next in importance to *Pheidole punctulata*. This ant is also widely spread, and when attended by it the mealy-bug sometimes becomes serious. Up to the present, however, observations tend to show that its numbers are less and its activities not so unremittent as those of *Pheidole punctulata*. If it be

found necessary to band against this ant, it may be mentioned that kresotow is as efficient for the purpose as it is against *Pheidole punctulata*.

The species of ant next in importance and fairly widely spread in Kiambu is apparently another species of *Pheidole* (not *punctulata*). This is a rather large ant with two castes of workers, the larger caste being generally present in very small numbers. Alone, this ant has never been seen with a serious attack of mealy-bug, but it may be present with either or both of the previously mentioned ants.

At least four other species of ants, some fairly widely spread, may attend the mealy-bug, but these are all of less importance, and their relationships with the Coccid may be only casual and not developed into a form of mutualism such as exists between the Coccid and *Pheidole punctulata*. These ants will probably prove to do nothing to increase the severity of mealy-bug attack, and from a practical point of view may be of no importance.

Observations and experiments on the incidence, activities and importance of these ants, the relationships of two or more species when present together, and other such points, are being made. It may be mentioned that kresotow has been found an efficient repellent for three species of ants attending mealy-bug, including *Pheidole punctulata* and *Acantholepis* sp., and it would probably be found a successful repellent for any other ant species against which it might be considered necessary to use it.

The other chief line of investigation undertaken was spraying. It was considered that a definite controlled test of the efficacy of spraying was desirable, both because sprays are used with fair success on a large scale for the control of similar Coccids in other parts of the world, and because it did not seem proven that it could not be useful in this Colony in conjunction with other control measures.

Experiments so far seem to show that although it is almost impossible in commercial practice to ensure that every twig and leaf of a coffee tree receives some of the spray, yet the mealy-bug may be reduced by spraying to such a large extent that the coccinellid predators are effectively able to control it, in cases where, before spraying, it was present in too great numbers and was reproducing too rapidly, for them to do so.

At least one spray has been tried which does not kill the larvæ, pupæ or adults of the important ladybirds. Further spraying experiments are to be made at times when the mealy-bug condition is suitable.

While it is thought that spraying can never prove a completely satisfactory control, yet in certain cases it may prove a valuable measure to supplement banding.

Another predator of mealy-bug has been found, a heteropterous bug, apparently an unidentified species of Anthocorid. It is common and widely spread in Kiambu, and is of some importance as one of the many controlling predators.

A piece of land, suitable for an experimental plot, has been kindly lent on an estate in the district, and this has been planted with coffee for experimental purposes. Other experiments with the mealy-bug and other coffee insects are being undertaken, but at present none of these has progressed sufficiently for anything useful to be said about it."—*Dr. Le Pelley*.

INSECTARIES.

On the 7th May some £9,000 was sanctioned by Government for building, equipping and managing insectaries for the breeding of predatory ladybirds which would eventually be distributed to the mealy-bug infested areas.

The work was begun on the 20th June, and the buildings, eight in number, were finally completed and ready for occupation by the beginning of November.

The buildings are arranged as a series of four units, each unit consisting of a potato-sprouting house and a rearing house.

The four potato-sprouting houses are equipped with iron staging capable of accommodating 1,512 trays, each tray being roughly 2 feet square and 4 inches in depth.

In these trays potatoes are planted with soil as a nidus and covering. When the sprouts have attained a certain size they are inoculated with mealy-bug and removed to the rearing cages. When the mealy-bug has fairly well covered the sprouts adult predators are introduced and allowed to breed. The average weight of a tray, plus potatoes plus soil, is 51.7 lb.

Each of the rearing houses is equipped with 118 cages, capable of taking two trays each, so that the four rearing houses can hold 944 trays at any one time.

Several difficulties have been met with in this attempted mass production of predators, the chief being that, from the time the work was started until the end of the year, the development of the mealy-bug has been exceedingly slow.

The raising of the temperature and/or increasing the atmospheric humidity has had little or no effect on the development of the mealy-bug. The development also of *Chilocorus angolensis*, the commonest predator found in mealy-bug areas, has been exceedingly slow in the insectaries, even with a sufficient food supply.

On the other hand, the introduced ladybird, *Cryptolæmus montrouzieri*, has, during the same period, multiplied rapidly. For the introduction of this predator we are indebted to Mr. T. J. Naude, Chief Entomologist, Department of Agriculture, Union of South Africa.

The following is the report of the insectaries manager, T. L. McClelland:—

“*Insectaries.*—Work began on these buildings on the 20th June. Four complete units have been built, each consisting of one potato-sprouting house and one rearing house. These buildings were finally completed on November 5th.

Potatoes.—Potato sprouting was commenced on the 27th June, and has been continued since then. At the end of the year 1,684 boxes had been laid down. It takes four to six weeks to bring sprouts to a maturity necessary for infecting with mealy-bug. This depends largely upon the type of potato used.

Mealy-bug.—The chief difficulty so far has been the lack of a sufficient quantity of mealy-bug for proper infection of sprouts. Also, commencing the work at what might be termed the close season for mealy-bug, it was found that infection spread very slowly. The first boxes of potatoes were infected on the 13th August, and it was about the end of October before these had reached a sufficient density to justify the introduction of ladybirds. It will be seen from this that it takes four to six weeks for potatoes to sprout and about two and a half months for mealy-bug to establish themselves properly on the sprouts, so that the total period from laying down potatoes until ready for predators is approximately three and a half months *at this season of the year*.

Ladybirds.—On August 14th, eight adult ladybirds (*Cryptolæmus montrouzieri*) were received from South Africa. These were placed in a small rearing cage in the Laboratory, and

fed on mealy-bug collected from neighbouring plantations. The first inspection and count of the progeny of these was made on September 12th, and gave as a result 47 larvæ and 2 pupæ. Successive counts were made up to the 9th December, when the total progeny of the original 3 *Cryptolæmus* numbered 3,000. Owing to lack of mealy-bug these could not be disposed of as rapidly as could be wished; however, 2,180 were distributed among 86 breeding cages, the balance being kept in the original cages."—*T. L. McCulland*.

Rules governing the issue and distribution of predatory ladybirds from the insectaries have been framed and circulated. These rules are as follows :—

1. All applications from planters should be addressed to the Insectaries Manager, Scott Agricultural Laboratories, Nairobi, and must be accompanied by the recommendation as described in paragraph 3. This recommendation will include an estimate of the numbers required.

2. All applications will be dealt with strictly in rotation.

3. Predators will be issued only on the recommendation of an Entomologist or Plantation Inspector, and such recommendation will not be made, except in special circumstances, unless the coffee bushes are so "banded" that the ladybirds will have a reasonable chance to multiply.

4. Notification will be given to planters when delivery can be taken.

5. Delivery must be taken by the planter or his agent at the Scott Agricultural Laboratories, and payment made prior to delivery.

6. The ladybirds will be charged for at the rate of Sh. 10 per 1,000, with a minimum order of Sh. 10.

7. Suitable receptacles will be provided by the Scott Agricultural Laboratories.

INOCULATION OF COFFEE BUSHES AS A CONTROL OF MEALY-BUG.

Communications continue to be received from various sources with regard to the inoculation of coffee bushes as a cure for all pests and diseases. The methods are described as "simplicity itself," and the advantages claimed are that :—

1. The inoculated insecticide, being of a poisonous nature, forms a poisonous sap, which means that the whole tree or plant is poisonous at all points, above and below ground, and destroys all manner of insects feeding on it.

2. The insecticide retains its strength for a whole season, so that only one operation is necessary.

3. It will give the maximum of efficiency, in that it destroys all insects.

4. It can be used at lower cost than any present method of control.

5. One person, using the method patented, can easily inoculate 400 trees a day single-handed, thereby obviating the labour question and the expense connected with it.

6. For inoculating no special apparatus is necessary.

Such are the claims, but, so far as I know, there is no record of any success met with by using this method. The trial which was conducted on coffee in the Ruiru district was a distinct failure in that, although the bush showed no ill effects, the mealy-bug was not destroyed or even controlled.

ASTEROLECANIUM COFFEEÆ, NEWST.

“ Numerous observations have convinced me that the incidence of this pest is correlated very closely to the following ecological conditions :—

1. A poor, hungry soil deficient in humus.
2. Areas of deficient rainfall where long spells of drought are not infrequent.
3. The optimum temperature occurs below 5,000 feet in situations close to the Equator. Above this altitude prolonged periods of relatively low temperature tend to keep it in check.

Generally speaking, attacks of *Asterolecanium* above 5,000 feet, especially in areas of good rainfall, are best dealt with by amelioration of the soil conditions. Such treatment especially refers to the establishment and maintenance of a reserve of humus in the soil. Below 5,000 feet, especially in the drier areas, soil amelioration will have to be carried out along with the treatment of attacked trees by contact insecticides soon after each rainy season.”—*Dr. James.*

Other scale insects on coffee, which have been dealt with during the year, are :—

Icerya nigroareolata, Newst.

Pseudococcus virgatus, Ckll.

Pulvinaria psidii, Mask.

Ceroplastes ceriferus, And.

Lecanium africanum, Newst.

Saissetia subhemisphærica, Newst.

Ischnaspis longirostris, Sign.

COFFEE BORERS.

Borers in the Berry.

During the anti-stephanoderes campaign, organised and directed by the Senior Coffee Officer, practically the whole of the material collected by the inspectors has been examined by me.

In many instances the inspectors had themselves examined the material, and only those beans which showed damage were forwarded for definite determination.

In order to arrive at some idea of the percentage of beans damaged by each and all of the borers, the inspectors were instructed to forward standard-sized samples, from the bushes, from the ground under the bushes, from the drying trays, and from stored dry coffee.

Counts were made from these samples, and the percentages of damaged beans are given below, together with an appendix showing a complete list of such counts.

After a little experience, it was found comparatively easy to tell which borer had been responsible for the damage, and that in the absence of living or dead insects or their larvæ.

The total number of beans examined probably exceeded 250,000. Where definite counts were made, 133,324 beans were examined; of these, 88.25 per cent showed no insect damage, the remainder showing borer damage of one kind or other.

A map was prepared of the most important coffee-growing areas of the Colony. The map, comprising the Nairobi, Ngong, Dagoretti, Kabete, Kiambu, Ruiru, Thika, Kakusi, Donyo Sabuk and Maragua areas, is on the scale of two inches to the mile, and measures some twelve feet long by six feet high. On it are marked the Land Office farm number for

each farm, the name of the owner, and shows, in colour, the distribution of the borers. It is intended to continue this map to include all coffee pests.

The insects known to bore in coffee berries in the Colony are :—

1. *Stephanoderes hampei*, Ferr. (Scolytidæ).
2. *Sophronica ventralis*, Auriv. (Cerambycidæ).
3. *Thliptoceras octoguttale*, Feld. (Pyralidæ).
4. *Eucosma nereidope*, Meyr. (Eucosmidæ).
5. *Deudoryx lorisona*, Hew. (Lycænidæ).

Stephanoderes hampei, Ferr.—No case has been recorded of *stephanoderes* attacking green, ripening or ripe berries. In all cases damages had been done to what is known locally as *buni* coffee. By *buni* is meant dry coffee which has not been pulped and fermented.

The first definite record of this borer in Kenya was from a plantation situated in the eastern Kiambu area, some twelve miles from Nairobi, in April, 1928. My determination was corroborated by the Imperial Bureau of Entomology.

At the present stage of the survey this pest seems to be confined to more or less definite areas, and to have been present in these areas for some time, although, on the other hand, no samples of coffee beans showing *stephanoderes* damage had been received either from planters or factories previous to April, 1928.

Several of the infested areas are widely separated, e.g. Kaimosi and Ruiru, with uninfested areas between; some areas show a fairly high percentage of infestation, while in others the percentage is small.

The outbreak, at the present stage of our investigations, cannot be explained by introduction from outside sources, and it would appear that *stephanoderes* is indigenous to this part of Africa, although it has not yet been recorded from any other plant than coffee, nor has it been found attacking the indigenous wild coffee of the Nandi country.

Those districts from which no specimens of damage due to this pest were received during the campaign are : Nairobi, Ngong, Dagoretti, Kabete, Trans Nzoia, Solai, Songhor, Muhoroni, Koru, Nyeri, Nanyuki.

Those districts from which *stephanoderes* damaged beans were received are : Kiambu, Ruiru, Thika, Makuyu, Kaimosi, Kericho, Sotik.

The percentage of infection in these districts was :—

	per cent
Kiambu	0.7
Ruiru	1.3
Thika	1.1
Makuyu	0.07
Kaimosi	8.2
Sotik, Kericho	7.8

Points to be considered in future work :—

1. A more detailed search for indigenous host plants.
2. Seeing that Kaimosi and Kericho have the heaviest rainfall, is the percentage of infestation in these districts high owing to the effect of the climate on the development of the beetle, or is this due entirely to the difficulty in having a thorough clean-up under the conditions obtaining?
3. What effects the better harvesting methods recommended by the Senior Coffee Officer, if properly carried out, will have in reducing the loss in the affected areas.
4. The treatment of infested material and its movement.
5. Further investigation into the factors responsible for the 1928 outbreak.
6. The effect of shade on the incidence of the pest. The only effect which has been noticed so far is that, in plantations in which a shade tree of the *Sesbania* type is used, the fallen leaves by covering the fallen berries, make it more difficult to have a thorough clean-up.

Sophronica ventralis, *Auriv.*—This beetle is much more widely distributed than *Stephanoderes*, and is responsible for more loss. It, also, has only been found in *buni* coffee on the bushes and on the ground, and will go on reproducing for several generations in dry coffee in stores. Several instances have come to notice where nothing was left of the original *buni* but a few chips. In one case several hundreds of pounds weight of *buni* must have been lost.

The percentage of damaged beans in the different districts was :—

	per cent
Nairobi, Ngong, Nagoretti	17.2
Kiambu	9.2
Upper Kiambu and Limuru ...	7.4
Ruiru	4.1
Thika	1.3
Makuyu, Fort Hall, Ithanga ...	1.2
Trans Nzoia	2.1
Kaimosi	0.1
Kericho, Sotik, Fort Ternan ...	1.7

Thliptoceras octoguttale, Feld.—Thliptoceras, the Coffee Berry Moth, is to be found wherever coffee is grown in the Colony. On hatching, the pinkish caterpillar bores into the green berry and feeds on the developing beans, which may be completely or partially destroyed. The net result is the same : The berries dry up, turn dark brown, and usually drop off. During its life, one caterpillar will damage many berries, boring into one and passing on to another, and in passing often leaves silken threads round the cluster which prevent the dry berries falling to the ground.

The percentage of infection in the different districts was :—

	per cent
Nairobi, Ngong, Dargoretti	1.5
Kiambu	3.1
Upper Kiambu and Limuru ...	2.3
Ruiru	1.8
Thika	1.5
Makuyu, Fort Hall, Ithanga ...	1.5
Trans Nzoia	35.0
Kaimosi	0.6
Kericho, Sotik, Fort Ternan ...	0.8

At present, the damage done by *Eucosma nereidope*, Meyr., and *Deudoryx lorisona*, Hew., is very small.

TOTALS FOR ALL DISTRICTS.

District	Beans examined	No insect damage	<i>Stephanoderes</i> damage	<i>Sophronica</i> damage	<i>Thliptoceras</i> damage	<i>Deudoryx</i> damage
Nairobi, Ngong, Dagoretti	12,137	9,854	—	2,094	189	—
Kiambu	16,442	14,161	118	1,526	520	117
Upper Kiambu, Limuru	11,901	10,734	3	885	277	2
Ruiru	38,579	35,774	526	1,583	696	—
Thika	4,226	4,110	48	58	10	—
Makuyu, Fort Hall, Ithanga	13,710	13,330	10	165	205	—
Trans Nzoia	11,140	6,990	—	240	3,910	—
Kaimosi	11,289	10,271	931	19	68	—
Kericho, Sotik, Lumbwa, Fort Teinan	13,900	12,445	1,096	246	113	—
Solai : No count made	..	..	..	..	..	..
Songhor, Muhoroni, Koru : No count made	..	..	..	..	..	..
Nyeri, Nanyuki : No count made	..	..	..	..	..	..
	133,324	117,669	2,732	6,816	5,988	119
		88.25%	2.04%	5.11%	4.41%	0.08%

Stem Borers.

The stem borers of coffee are :—

Anthores leuconotus, Pasc., The White Borer.

Dirphya princeps, Jord., The Yellow-headed Borer.

Apate monacha, F., The Black Borer.

Two other species, still undetermined, have been recorded for the first time.

Anthores leuconotus, Pasc.

“ This pest has again caused a considerable mortality among coffee trees in certain low-lying districts during the past year, and, owing to its ravages, two plantations have had to be destroyed. It is found that native labour objects to roughing the bark by hand in order to secure and destroy the larvæ in the early stages. It is therefore necessary to supply them with a piece of sacking or other rough fabric or the work will not be done thoroughly. In some of the lowest areas where coffee is grown it would probably pay to maintain a few totos on piece work collecting grubs throughout the year. In this connexion, however, planters are advised to obtain a knowledge of the appearance of the white borer grub or they will disburse considerable sums in return for grubs, harmless to coffee, which have been collected from the surrounding indigenous timber.”—*Dr. James.*

Dirphya princeps, Jord.

Although several plantations have notified the presence of this borer, it is neither actually nor potentially so serious a pest as the White Borer.

Apate monacha, F., was recorded from Nyeri, Donyo Sabuk, and Kipkarren.

The larva of a Longicorn, probably a species of *Bixadus*, was reported as boring in coffee at Kaimosi. The adults were eating the bark of the primaries.

In the Maragua area, another borer was found for the first time. Both of these have been sent home for identification.

Antestia lineaticollis, Stal.

This bug has been responsible for a considerable amount of damage, more especially in those districts where rain interferes with spraying. On the other hand, in areas where severe damage was done some years ago, *Antestia* has been successfully controlled by the arsenite spray.

MAIZE.

On October 8th, Mr. Wilkinson was transferred to Nakuru to investigate cutworms, stalk borer and cereal pests generally. He reports :—

“ Since that time until December 31st, thorough search has been made for these insects (cutworms) in any stage but with little result. Digging in the soil to a depth of two feet and following the plough in different areas during ploughing operations has revealed only eight larvæ in different stages of development. Not one single pupa or pupal case has been found. In addition, only two moths have been caught. These were caught at light on the night of the 14th November. In the present stage of these investigations no explanation can be offered for these surprising results. The evidence obtained from various planters during my investigations goes to prove that maize crops suffer only slightly from the attacks of cutworms when the seed is planted within about three weeks of the advent of the long rains. Crops planted after this time are said to suffer so considerably that it becomes necessary to plant as often as three times before a good stand of maize is obtained. Steps are being taken by many maize growers to so increase the number of planting machines as to be able to complete planting operations within the above period of three weeks.”

The problems of insect control in this Colony are unquestionably increasing in number and in economic importance.

The increasing interest on the part of the general public that is being paid to the subject of scientific research, public sentiment against neglected and infested estates, the adaptation of pests to new host plants, the adoption of more scientific methods in agriculture, and the rapid growth of cultivation and production have all helped to increase the problems of insect control.

That on agriculture depends the prosperity of the Colony is now less an oratorical expression and more an established axiom. Success and financial security depend upon advance in scientific agriculture, but increased production cannot be secured by the mere increase of the total area brought under the plough.

Crop protection must go hand in hand with crop production, or be in advance of it, and it is in this connexion that the results of scientific research on insect pests find their practical value and application.

No one can deny that pests exact an enormous toll from everything grown in every part of the Colony, and also that insects work insidiously and that their damage is often widespread before it is sufficiently realised.

The annual loss due to insects cannot, at present, be expressed in figures, but it is far in excess of what it might be.

T. J. ANDERSON,
Entomologist.

APPENDIX G.

ANNUAL REPORT OF THE MYCOLOGIST FOR 1929.

STAFF.

The staff throughout the year consisted of—

Mr. J. McDonald, Mycologist;

Mr. F. W. Evans, Junior Laboratory Assistant.

TRAVELLING.

Approximately 2,500 miles were covered in travelling on duty in Kenya, during the course of which 81 farms were visited. The chief journeys were made as follows :—

June.—To Kisumu district in connexion with the sugar mosaic eradication campaign.

September.—To Kipkarren, Trans Nzoia, Uasin Gishu, Eldama Ravine, Rongai, Solai and Nakuru districts, on investigations mainly concerned with maize leaf blight in the first three districts and maize smut in the last four. Coffee, wheat and barley diseases also received attention.

November-December.—To Sotik and Kericho, chiefly in connexion with the control of coffee berry disease, and to Nakuru to attend the Agricultural Show in December.

In addition to the above, I was absent from Nairobi from July 12th till August 24th in order to attend, as one of the Kenya delegates, the Pan-African Agricultural and Veterinary Conference held at Pretoria, South Africa. This visit is dealt with later in this report.

CORRESPONDENCE.

Inward letters numbered 774; outward letters 594.

Inquiries regarding diseases covering a range of 31 different hosts were dealt with. A larger proportion than usual was concerned with coffee, the increase being due in part to the numerous specimens submitted by plantation inspectors, during the systematic inspection of coffee throughout the country which took place in 1929.

A number of plants submitted for identification were reported on. These included some plants believed to be useful and some considered harmful. Amongst the former were plants of possible use medically, for the extraction of essential oils, as pasture plants or as green manures. In the harmful

class, specimens were received of troublesome crop weeds, suspected poisonous plants, parasitic plants and weeds suspected of being the cause of tainted milk.

Other correspondence included matters connected with the administration of the Plant Disease Prevention Ordinance, the sugar mosaic eradication campaign, and, towards the close of the year, the striga eradication campaign to be begun in 1930.

The usual correspondence with plant pathologists in other countries was maintained.

INVESTIGATIONAL WORK.

Wheat.

In my report for 1928 the discovery of the existence of at least two different physiologic forms of wheat stem rust (*Puccinia graminis tritici*) was recorded. It was hoped to follow this up in 1929 by a further extensive search for undiscovered forms. Farmers in a number of districts were therefore requested to forward samples of rust as soon as they were obtainable, and certain officers of the Department of Agriculture were also asked to help. Unfortunately from the mycological point of view—although not from the farmer's!—stem rust proved extremely scarce or even entirely absent in several districts for most of the growing season. It was found possible, nevertheless, to make eleven tests at different times with rust from eight districts. In every case, however, the rust present proved to be one or the other of the two forms, K1 and K2, previously discovered. Thus, as far as is known at present, only two forms exist in Kenya.

It was also hoped by obtaining rust samples at different times of the year in the same districts to collect information bearing on the movements of the two forms. For the reason stated in the previous paragraph, this proved largely impossible. At Nairobi, however, it was found possible to make three such tests, as a result of which the return of form K1 was noted in July after an absence of over twelve months.

Since the wheat stem rust investigations were begun towards the end of 1927, twenty-two tests of the forms present in different districts have been made. These include five at Nairobi and four at Njoro, at various times. Form K1 has been found twelve times, K2 ten times, and both forms twice together. It has not so far been possible to detect any likely connexion between the appearance of either form and particular areas, altitudes or seasons of the year.

Considerable work has been done during the year in making hundreds of measurements of spores of the two rust forms. As a result a significant difference between their dimensions has been demonstrated, thus providing additional proof that the forms are distinct from one another. The measurements obtained for one of the forms adds strong evidence in favour of the opinion already held that it is identical with one occurring in America.

The routine testing of the Plant Breeder's new hybrid selections by the method of artificial inoculation with the two rust forms, which was begun in 1928, was carried on more extensively in 1929. Including a few named wheats imported from other countries, approximately 170 varieties were tested with each form. An outstanding feature of the results obtained has been the comparatively small percentage of the wheats artificially tested which have proved resistant to both rust forms, although a large number of them, judging by field observations only, over a number of years, had been thought to possess considerable rust resistance. Under the method of artificial inoculation carried out at the laboratories, conditions are made highly favourable to rust, so that the result obtained may be taken with fair confidence as representing the worst degree of infection which each variety is ever likely to exhibit under field conditions conducive to rust. It is thus possible to predict that some varieties which have never been known to be badly attacked by rust in the field, would if grown in some future season when conditions are particularly favourable to infection, succumb to the disease. An interesting example of this has actually occurred in the laboratory field plots this last season. Four plots of different varieties, none of which had been known to suffer badly from rust in the past, were grown. Under artificial inoculation tests, three of these varieties had been recorded as susceptible and the fourth as resistant to form K1. This form was present at the end of the season and just those three varieties, which had been shown by artificial methods to be potentially susceptible, were considerably attacked in the field for the first time, while the fourth remained but slightly affected.

The artificial tests have sometimes proved of value in detecting hybrid selections which, on the evidence of field tests, were believed to have reached a state of purity as far as the rust resistance character was concerned, but which actually still contained a mixture of resistant and susceptible seed. Batches of seedlings raised from such seed, when artificially

inoculated have shown mixed susceptible and resistant types of reactions in different plants and thus have indicated the necessity for further selection.

The tests have also been the means of emphasising the lack of success likely to attend the importation of foreign wheat varieties, of which the resistance to Kenya rust forms is unknown. In one case of 15 such varieties submitted for testing, every variety gave a susceptible reaction with form K1 and only a few showed resistance to form K2. Thus not a single one of those wheats could be grown with any prospect of consistent success in Kenya.

During the latter half of the year, much of the routine testing of hybrid selections was in the hands of Mr. F. W. Evans, who carried out the work very successfully.

COFFEE.

During my visit to Kericho and Sotik in November, I made considerable field investigations in the reported severity of berry disease. I found that about five farms only had suffered severely from the disease in 1929 while most of the rest reported slight losses or severe attack confined to patches. Of the cases of considerable general infection, one plantation was seen to be suffering from dieback, leaf disease and brown blight, indicating general lack of vigour; another had suffered severely from wash and in another, where spraying had been said to be a failure, pruning was so much in arrears as to make efficient spraying difficult, if not impossible, while the bushes were carrying a burden of useless wood.

On the question of the efficiency of spraying, most farmers were of the opinion that it was decidedly beneficial. It has never been claimed that spraying alone would completely rid plantations of berry disease, but there can be no doubt that it is a valuable aid to prevention. At my request, spraying tests were carried out by Messrs. S. Lydford, Kericho, and T. H. Brown, Kaimosi, using carbide mixture with and without a casein adhesive. As a result it was concluded that the adhesive made little difference to the effectiveness of the spray, which has ample adhesive qualities if given an hour or two in which to dry after application. My best thanks are due to these gentlemen for their assistance in this and other directions during the year.

During the tour under discussion, opportunities arose of confirming various views previously held concerning berry disease. In this connexion it was outstandingly noticeable that

the first crop from seed and the first crop produced on young shoots arising after stumping old bushes were invariably practically free from the disease, even when older coffee in its immediate vicinity was severely affected. This observation is again referred to below. Planters generally were agreed that berry disease is worst in July and August and that thereafter there is a falling off in the degree of infection. This conforms with the view held by the Senior Coffee Officer and myself that some change takes place, when the coffee beans pass from the milky to the hard stage, which renders them less susceptible to the disease. This change normally occurs about September.

Inquiries were specially made wherever possible as to the effect of applications of lime and artificial fertilisers. Unfortunately the cost of transport from the railway has militated against much experiment with these. In the case of artificial fertilisers very little had been done and it would be unwise to attach any importance to the results obtained, although these were claimed to be favourable. A few experiments with lime had been made and, with one exception, greater freedom from berry disease was reported. In the exceptional case, the application had been small and for one season only.

I have long held the view that in many cases predisposition to attack by berry disease is probably bound up with soil factors. In a few instances certain soil investigations in connexion with the disease have been made by the Assistant Agricultural Chemist (Mr. Gracie) but the few results obtained have been conflicting in some respects. The need for a comprehensive soil investigation in its relation to berry disease is fully realised but unfortunately Mr. Gracie's time has been so fully occupied in other soil problems that the opportunity to devote the necessary attention to berry disease has not yet occurred. It was hoped that before 1930, sufficient chemical data to form a basis for fertiliser or lime experiments would be available but, although it has not been possible to obtain these, plans are in hand to carry out such experiments based on general pathological considerations.

The observation made above that first crops from new plantings or from new shoots from stumped coffee are normally free from berry disease, even when older neighbouring trees are suffering severely, is capable of various explanations. The roots of the young trees are operating in virgin soil and at no great depth, while those of recently stumped coffee occupy a

relatively large soil volume from which to supply the comparatively small needs of the new shoots which have developed. The freedom from berry disease of coffee berries produced under such conditions might, therefore, lend support to a supposition that lack of some essential substance in the berries may be a factor predisposing them to the disease. Among possible soil conditions which might produce such a state of affairs are actual deficiency of an essential element or excessive acidity rendering food materials non-available. Certain results having an indirect bearing on the latter possibility have recently been obtained in the laboratory.

In one district visited in 1929, a coffee farmer claimed that one of his coffee blocks which had received dressings of lime was free from berry disease, while his neighbour's coffee, of about the same age and growing within a few yards, but not limed, was appreciably infected. Random samples of green berries from both areas were obtained, and culture media were made from both, using precisely the same method. The two strains of the fungus *Colletotrichum coffeanum*, Noack, which are respectively the cause of berry disease and brown blight, were then grown on these media, and it was found that both exhibited certain definite growth features on one of the media which were lacking in the corresponding cultures on the other medium, thus indicating a difference in chemical constitution of the berry samples from which the media were made.

During the latter half of 1929, specimens of coffee berries exhibiting similar disease symptoms were received from four different districts. The pulp of the berries in each case was brown, dried-up and brittle, while the beans were usually considerably decayed. The general symptoms were very similar to those of coffee berry disease, with the difference, however, that the dried pulp of the specimens under discussion had the appearance of being covered in minute, dirty-white excrescences, a condition not occurring in berry disease specimens. The presence of these excrescences has led to the application of the name "warty coffee" to the disease.

Laboratory examination of the specimens submitted showed the presence of a species of *Botrytis* on some of them, and, in culture, a sclerotial fungus was readily obtained from the berries from all four districts, although in the case of one district the fungus appeared to be of a different strain from that obtained in the other three cases.

Preliminary laboratory inoculation experiments have succeeded in reproducing the disease artificially with the commoner strain, but on a very limited scale.

The importance of the disease has not yet been fully ascertained, but it does not appear to be common, and it is not thought likely that it will prove a serious trouble. Up to the present no account of the occurrence of a similar disease elsewhere has been found. Further inquiries and investigations are in progress.

Maize.

Considerable laboratory work was carried out on different maize diseases during the year. Arising out of questions relating to leaf blight (*Helminthosporium turcicum*, Pass.), an examination of seeds from crops which had suffered from the disease was undertaken to discover whether the causal fungus could be found on or in the tissues of such seeds. The work was later extended to determine what fungi were commonly present on maize seed obtained from different districts in Kenya.

The results obtained were interesting in several respects. In no case was the leaf blight fungus found, even when seed was specially obtained from crops known to have suffered severely from the disease. The organism, however, was readily isolated in culture from spots on maize leaves, and an experiment was carried out in which the fungus was placed in contact with the germ end of the seed at the time of planting. No harmful result was observed either to germinating power or to the plants produced. In another experiment, two plots of approximately one-fifteenth of an acre each were sown respectively with specially selected maize seed from a crop which had been grown at the Laboratories, and which had been scarcely attacked by leaf blight, and with seed obtained from a badly affected crop on the Uasin Gishu Plateau. The latter seed was markedly smaller and poorer in appearance than the former, but showed no special evidence of disease attack. It gave 85 per cent of the stand theoretically possible, as against 90 per cent from the selected seed. The season was a good one, and the land had been well prepared beforehand. Throughout their growth the plots sown with the two different batches of seed showed little difference in vigour. Leaf blight spots began to appear in six to seven weeks on leaves of the plants in both plots. They were few in number, and about equally distributed in the two plots. The spots developed

slowly, and their effect on yield was probably negligible. The yields from the specially selected seed and from that from the crop affected by leaf blight were respectively at the rate of 31.1 and 28.9 bags shelled maize per acre. It is not proposed to suggest that these yields could be expected under ordinary farming conditions, and it is candidly admitted that the maize when weighed probably contained somewhat above the moisture allowance for export maize. It was, however, dry enough to be readily shelled in an ordinary sheller. After making all allowances, it is still evident that the maize from seed from the badly leaf-blighted crop of the previous season did not suffer from leaf blight more than the crop from specially selected seed. The crop attacked by leaf blight on the Uasin Gishu Plateau in 1928 was grown on land known to be capable of producing good yields, and yet, under climatic conditions favourable to leaf blight in that year, the yield was only seven bags per acre. An important point to be borne in mind is that the seed used for the crop which succumbed to leaf blight had not been selected scientifically, either for resistance to leaf blight or for the ordinary desirable characters for which maize selection should be normally carried out. Selection as a valuable measure in the control of leaf blight has been advocated in maize disease bulletins of the Department of Agriculture for years, and strong evidence in support of this advice was forthcoming in 1929.

During the epidemic of leaf blight in 1928, the Plant Breeder co-operated by arranging to have seed selected in an affected district, from plants which appeared resistant to the disease in badly blighted crops. Ear-to-row tests were made in the same district in 1929, using the seed thus selected in competition with ample control rows from unselected ears. The results were outstandingly in favour of the selected seed, so much so that anyone unacquainted with the plan of the experiment could have picked out the control rows without difficulty on account of their susceptibility and consequent poor appearance. During my tour in September also, I saw striking evidence of the beneficial results of systematic routine seed selection, carried out over a number of years, without special reference to leaf blight. One such seed selection plot, not far removed from the worst affected farms, contained hardly a trace of leaf blight. In such cases, unconscious selection against the disease is actually carried out, since plants attacked by it would normally be so lacking in general vigour as to be rejected for seed purposes.

As a result of the laboratory examination already mentioned, of samples of maize seed from different districts, it was found in every case that a large proportion of the seed carried the ear rot fungus (*Gibberella saubinetii* (Mont.) Sacc.) superficially, even when no trace of the disease could be seen with the naked eye. The tissues of some of the seeds were actually invaded by the fungus, and germination tests showed that such seeds either germinated less vigorously than those which were not attacked or, in bad cases, did not germinate at all.

Several experiments were carried out in which seeds, taken at random from large samples, were allowed to germinate in culture dishes containing a nutrient medium suitable for the growth of fungi. By this means it was possible to observe the fungi which developed from the maize seeds and their effect on the germinating power of the seeds. Under the conditions obtaining in the dishes, it was found that whenever the ear rot fungus developed it speedily attacked the roots of the germinating seed, causing their complete decay. In a previous annual report (1925), it was mentioned that this fungus in America is known to cause root rot and seedling diseases of maize, not known to have occurred in Kenya. Attempts were therefore made to produce such diseases by artificially infecting maize seed, planted in pots, with the ear rot fungus. Root rot and seedling blight were successfully produced by this means, but only when the seeds were sown in previously sterilised soil.

Certain other fungi, capable of attacking the roots of seedlings, developed in the culture dishes occasionally. These included a *Fusarium* sp. and *Nigrospora sphaerica* (Sacc.) Mason. The former was reported by the Imperial Bureau of Mycology, to whom it was sent for examination, as not appearing to be one of the more usual cereal *Fusaria*. Whether either of these fungi is of economic importance in Kenya is not yet known.

Another fungus which was found on maize kernels was identified at the Imperial Bureau of Mycology as *Nigrospora orizæ* (B. and Br.) Petch. There is reason to believe that this organism may be identical with a fungus known as *Basisporium gallarum*, Moll., which causes a rotting of maize shanks and ear tissues in certain parts of America.

In the course of my tour in September, I found near Kitale, a dead maize stalk bearing fructifications of a fungus, lying beside a field of growing maize. This dead stalk was

later examined in the laboratory, when the fungus was identified as *Diplodia zeæ* (Schw.) Lev., the cause of an important dry rot of maize in South Africa, America and elsewhere. The disease has not yet been found on the living host in Kenya, but it is probable that it soon will be. An article on dry rot was published in the local Press as soon as possible after the discovery of the fungus.

Another fungus, isolated from pale spots on a maize leaf, was identified at the Imperial Bureau of Mycology as *Papularia sphærosperma* (Pers.) von Hohnel. This fungus is probably unimportant economically.

Barley.

It was reported last year that a species of *Helminthosporium* had been isolated in the laboratories from diseased barley leaves exhibiting brown spots amongst other symptoms. Cultures from similar spots were sent to the Imperial Bureau of Mycology, where the fungus was identified as *Helminthosporium teres* Sacc. This is the fungus which causes the disease known as "net blotch" in America, where, however, it is not considered particularly destructive. Three species of *Helminthosporium* are known to cause disease in barley in other parts of the world, and it is thought that since, in one case at least, the affected barley appeared to have suffered more than would have been expected if the "net blotch" *Helminthosporium* only had been present, one of the other species may also have attacked the crop, but may have escaped detection. The matter is being followed up by a search for one of these other species.

It was found early in the year that, owing to a misunderstanding, a number of farmers had been treating their barley seed with a copper carbonate dust as a preventive of covered smut (*Ustilago hordei* (Pers.) Kell. and Sw.). Although it was known that this substance is not recommended elsewhere against covered smut, it was considered advisable to carry out tests and make observations in the field on the effectiveness or otherwise of this treatment, in order to have first hand information under local conditions. It was found that copper carbonate dust was ineffective as a control for covered smut of barley, and farmers are therefore advised to discontinue its use in favour of the formalin method practised hitherto.

Sisal.

It was hoped to make further investigations on the cool weather injury of sisal leaves described as Type B in last year's Annual Report. Pressure of work during the favourable period

of the year, however, considerably limited the experiments, and little more was done than to confirm last year's observation that this type of injury could be artificially produced by merely covering the freshly cut leaves with sacking during cool weather.

SPECIAL WORK.

I left Nairobi on July 12th to attend the Pan-African Agricultural and Veterinary Conference at Pretoria, South Africa, as one of the Kenya delegates.

While in South Africa I visited the following institutions :—

The Mycological Laboratories and Sugar Cane Importation Quarantine Greenhouse, Durban.

The South African Sugar Association Experiment Station, Mount Edgecombe, Natal.

The School of Agriculture, Cedara, Natal.

The School of Agriculture, Potchefstroom, Transvaal.

The Division of Botany, Pretoria.

The Veterinary Research Laboratories, Onderstepoort.

At all the above institutions I was cordially received and given every opportunity of inspecting the work in progress and of discussing problems with the members of the various staffs.

The Pan African Conference was officially opened on August 1st, after which it was adjourned till the 6th, to enable delegates to attend the meetings of the British Association, Section M (Agriculture). On resuming, the Conference was divided into two sections—Agricultural and Veterinary. I attended the meetings of the former, and took part in the discussions on a number of subjects. While the Senior Agricultural Officer (Mr. Blunt) dealt with matters of general agricultural interest, I presented the views of the Kenya agricultural research officers on botanical, mycological, entomological and plant breeding subjects. At the invitation of the chairman, I opened the discussions under the heads of "Diseases of coffee," and "The resistant plant as a factor in disease control in Africa," and I was appointed a member of a committee on the "Advisability of inter-state co-ordination of plant protection measures in Africa." A full report of the Conference will doubtless be issued in due course.

I regard my visit to South Africa as an experience of great value, especially in the opportunities which it provided of obtaining information on work done or in progress, of meeting specialists in particular branches, and of obtaining ideas for future application to my own work.

I returned to Nairobi on August 23rd.

ROUTINE WORK.

Sugar Cane.

In connexion with the mosaic disease eradication campaign, a thorough systematic inspection of the whole of Kisumu-Londiani district was carried out by a plantation inspector in June and a re-inspection was made in December. As a result, it is now known that only a trace of susceptible varieties, existing almost entirely as rogues in crops of the Uba variety, now remains in that district. One successful prosecution was instituted for non-fulfilment of an eradication order.

I record with regret that, with one or two very minor exceptions, the only trouble encountered in carrying out the eradication campaign has been on certain European estates. Most Europeans have loyally co-operated, but others have not been as energetic as they might have been in eradicating the last remaining rogues of susceptible varieties. A number of reports have been received of the occurrence of mosaic in cane growing outside the gazetted area. Such alleged occurrences of mosaic disease have been very carefully investigated by the Agricultural Department without so far discovering a trace of the disease.

The position at the end of 1929 was that no single case of mosaic disease was known to exist outside the Kisumu-Londiani gazetted area, while within that area only the merest trace remained. This, however, is sufficient to maintain the infection, and new susceptible varieties cannot safely be introduced while the disease is still present.

Through the courtesy of Mr. Dodds, the Director of the South African Sugar Experiment Station, Natal, and Mr. McClean, the Natal mycologist, setts of P.O.J. 2878, 2722, and 2714 were obtained and planted in quarantine in January. Unfortunately, only the first of these successfully survived the journey, but it has, however, made good growth. The canes imported officially in 1928 and mentioned in last year's report, have made healthy growth, and it is hoped to issue setts of

these to growers in clean areas in 1930. A private importation which had been growing for twelve months in quarantine was released in October for removal by the owners, but had not been cut at the end of the year. A further smaller importation made by the same firm during 1929 was received into quarantine.

In January, six lectures were given to temporary inspectors employed in connexion with the anti-stephanoderes campaign.

Five lectures as follows were given to farmers' organisations :—

Coffee diseases—

To Kipkarren Branch of Coffee Planters' Union.

To Kericho Farmers' Association.

To Sotik Farmers' Association.

Coffee and maize diseases—

To Trans Nzoia Farmers' Association.

To Farmers' Associations in Nakuru area.

The following articles and bulletins were written :—

Bulletins—

“ A List of Plant Diseases in Kenya Colony.”

“ Notes on Physiologic Forms of Wheat Stem Rust in Kenya Colony and their bearing on Wheat Breeding.”

“ Notes on Coffee Diseases in Kenya.”

“ Notes on Maize Diseases in Kenya.”

(The last three above were prepared for the information of the Pan-African Agricultural and Veterinary Conference held at Pretoria, but were also issued as Departmental bulletins.)

Press article—

“ Dry Rot of Maize.”

Subcultures of the soy bean nodule organism were made from cultures obtained from America by the Agricultural Officer at the Scott Agricultural Laboratories (Mr. Lyne Watt), and used, together with the original cultures, to inoculate seed beds at the Laboratories. These were successfully inoculated, and soil from them and cultures of the organism were distributed to a few settlers interested in the cultivation of soy beans.

Duplicate collections of plants were forwarded to the Royal Botanic Gardens, Kew, for identification. On receipt of the names of the plants, the originals were classified and added to the herbarium.

The usual inspections of plants and seeds imported through the parcels post were made at the General Post Office, Nairobi, as required.

GENERAL OBSERVATIONS AND REMARKS.

Losses from fungous diseases were more severe than usual in 1929. Early in the year severe attacks of wheat stem rust occurred on susceptible varieties at Molo and Thomson's Falls and, during the season, leaf blight of maize considerably reduced yields on certain farms in the Trans Nzoia. The distribution of this disease, however, was not nearly so widespread as in 1928. Head smut of maize (*Sorosporium reilianum* (Kuhn) McAlp.) was particularly destructive in parts of Nakuru district; covered smut of barley was prevalent in some crops in the same area, and coffee berry disease caused severe damage on certain farms, particularly in Kericho and Sotik.

The damage due to head smut of maize reached alarming proportions on particular farms. I myself estimated losses of 16 to 17 per cent, counting infected tassels only; but, since ears may sometimes be smutted, while the tassel on the same plant is unaffected, such an estimate probably represents over 20 per cent infection. I received what appeared to be reliable reports of infection of over 40 per cent, made from actual counts, in extreme cases.

The system of growing maize year after year on the same land is highly conducive to severe attacks of smut in favourable seasons, and the greatest vigilance is required under such conditions to control infection. A number of farmers have been successful in keeping the disease in check by early destruction of smutted plants, but many have unquestionably failed to carry out such measures sufficiently promptly. Reports of the occurrence of smut on new land have been made, and have been considered to indicate that the land was already infected before it was cleared. Such occurrences are more likely to have been the result of transference of infective material through the agency of "dust devils," which are prevalent in the affected area at certain seasons, or on the feet of oxen, wheels of carts or on farm implements. Much carelessness in the method of disposal of smutted plants occurs.

These are rarely destroyed immediately, but are left in heaps beside the fields for days, while instances have been seen where these heaps were actually left on roadways in frequent use.

Striga hermonthica, the parasitic weed occurring on maize, sorghum and other cereals in Nyanza Province, is considered by many to be on the increase, and to present cause for alarm, owing to the failure of a number of individuals to take effective measures for its control. In response to the representations of farmers' associations, it is proposed to carry out an anti-striga campaign in 1930, in connexion with which preliminary arrangements have already been made.

The following are new fungus records for Kenya obtained in 1929 :—

Maize.

Dry rot, *Diplodia zeæ* (Schw.) Lev. On dead stalk; not yet known on living host.

On seed : *Nigrospora oryzae* (B. and Br.) Petch.

In culture from seed : *Nigrospora sphaerica* (Sacc.) Mason.

On leaf : *Papularia sphaerosperma* (Pers.) von Hohnel.

Coffee (*Coffea arabica* L.).

On fruits : *Botrytis* sp. ? *B. cinerea* Pers.

Barley.

Net blotch, *Helminthosporium teres* Sacc.

Yellow rust, *Puccinia glumarum* Eriks. and Henn.

Apples.

Cracking disease, *Coniothecium chomatosporum* Corda.

Pear.

Cracking disease, *Coniothecium chomatosporum* Corda.

Sugar.

Ring spot on leaves, *Letosphæria sacchari* van Breda.

New Zealand Flax (*Phormium tenax*).

On leaves : *Physalospora* sp.

Carnation.

Leaf spot, *Septoria dianthi* Desm.

Leaf spot, *Heterosporium echinulatum* (Berk.) Cke.

Datura stramonium L.

Leaf spot, *Alternaria crassa* (Sacc.) Rands.

Glycine javanica L.

Leaf disease, *Woroninella dolichi* (Che.) Sydow.

Euphorbia heterophylla L.

Rust, *Uredo Euphorbiæ-Engleri* P. Henn.

Wood-destroying fungi on dead logs or branches of unknown hosts :—

Hydnum glabrescens Berk. and Rav.

Lopharia mirabilis (B. and Br.) Pat.

Stereum insigne Bres.

The flowering plant, parasitic on leguminous crops, and mentioned in last year's Report as a species of *Alectra*, has since been identified at Kew as *Alectra Vogelii* Benth.

It remains in conclusion to acknowledge the very valuable assistance received from the Directors and Staffs of the Royal Botanic Gardens and the Imperial Bureau of Mycology, Kew.

J. McDONALD,
Mycologist.

APPENDIX H.

ANNUAL REPORT OF THE PLANT BREEDER
FOR 1929.

I do not propose to discuss and describe the work done by the Plant Breeding Services in the same detail as last year. Similar sort of work is done every year, but as it had not been described in detail before, it was so described last year. Where work or experiments are shortly described in this report, reference should therefore be made to my last year's report if further details are required as to the origin and purpose of the work.

I have just written a pamphlet giving advice to farmers on maize seed selection, and on the importance of obtaining good and even stands of maize. Notes on the subject are included in this report, but for a fuller account readers are referred to the bulletin on the subject, No. 2 of 1930, or the account in the Press.

STAFF.

The staff of the Plant Breeding Services consisted of :—

Mr. G. J. L. Burton, M.C., B.A., Plant Breeder ;
Mr. R. J. Lathbury, M.A., Assistant Plant Breeder ;
Mr. N. D. Spranger, Assistant Agricultural Officer ;
Mr. R. N. Noble, Laboratory Assistant.

The first three officers were permanently stationed at Njoro Plant Breeding Station, and Mr. R. N. Noble at the Scott Agricultural Laboratories. The Plant Breeder, however, divided his time as usual between the Njoro Plant Breeding Station, the Scott Agricultural Laboratories and the Mau Summit Plant Breeding Station.

Mr. R. J. Lathbury was absent on home leave from 21st April, 1929, to 6th November, 1929. During his leave he spent some time at Cambridge University studying the plant breeding work carried out there.

CORRESPONDENCE.

In addition to routine correspondence on plant breeding, a considerable quantity of correspondence was dealt with on all matters relating to arable farming. The distribution of considerable numbers of new wheats to farmers involved an additional amount of work, both as regards the organisation of the distribution and correspondence relative thereto.

TRAVELLING.

Five thousand and seventy-two miles were covered by car on Government service :—

Mr. G. J. L. Burton	... ..	3,046
Mr. R. J. Lathbury	... ..	778
Mr. N. D. Spranger	... ..	1,248

The number of nights spent away from Njoro Plant Breeding Station were approximately as follows :—

Mr. G. J. L. Burton	... ..	152
Mr. R. J. Lathbury	... ..	6
Mr. N. D. Spranger	... ..	12

Most of my travelling consisted in visiting wheat and maize farms and in journeys between the two main Plant Breeding Stations.

STEM RUST IN WHEAT.

The Mycologist has continued to collaborate with me in the best possible spirit in the matter of inoculating large numbers of my new wheats with both physiologic forms of stem rust present in the Colony in order to determine their physiologic resistance. When this work is completed on the present batch of wheats it will be possible for me, in conjunction with the field results, to know definitely which strains are of high resistance to stem rust and which are not.

Experiments completed to date indicate that many of the strains previously considered to be resistant to both forms are only resistant to one and moderately susceptible to the other. The reason for these wheats still being in existence is undoubtedly that in the past both forms have not regularly occurred year by year whilst the wheats were growing, and in cases where any particular form was present conditions have not always been such as to cause it to manifest itself to any extent. At the same time, a considerable number of strains of wheat have proved themselves, both physiologically and in the field, to be resistant to both forms, and it is proposed to continue multiplying these for issue in bulk. Furthermore, some of these resistant strains are so similar in appearance and quality etc., that they can be put together and the quantity of seed of any one type considerably increased thereby. The above remarks indicate the value of the work carried out for me by the Mycologist during the year. At the same time samples of stem rust have been sent him from different parts of the

Colony, including the Plant Breeding Stations, so that he could determine which physiologic form of stem rust was present. Such information is of the greatest value to me in that I know to which physiologic form the wheats, both pure lines and hybrids, have been exposed.

One of the great difficulties experienced in producing wheats resistant to stem rust is that any one physiologic form of stem rust may not occur at any Plant Breeding Station for several years in succession. In consequence of this, enormous quantities of wheat may be and are kept on for several years and even multiplied without being certain whether they are really resistant to both forms or not. If this goes on too long the situation becomes impossible. It has been decided therefore to conduct routine inoculation experiments on somewhat different lines than in the past. Instead of small numbers of wheats being inoculated in dribblets throughout the year by the Mycologist, it has been decided to do a very large number every year during the period between harvest and sowing. It will therefore no longer be necessary to sow such large numbers of wheats every year in case inoculation tests carried out during the year show some of them to be physiologically resistant. It will now be possible to discard large numbers before sowing time arrives, and to deal with that side of wheat breeding work by the simple and certain method of inoculation, leaving other characteristics to be dealt with in the field. The staff of the Plant Breeding Services will undertake this routine work in future. The Mycologist has kindly consented to act in an advisory capacity and to help as far as his own duties allow. Large cages are now being built for inoculation purposes at the Scott Agricultural Laboratories and several hundred plots are being made in which to grow the wheats.

WHEAT BREEDING.

Scott Laboratories Plant Breeding Station.

Large numbers of hybrid cultures of wheats were grown in the cage and outside. These consisted partly of F_7 and F_8 families from crosses made several years ago, and partly of some very promising natural hybrids found growing amongst crops of the new wheat B. 286.

The families first referred to are the last progeny of the original crosses I made. Grain from all the useful plants found in them will be inoculated under the new organisation to decide whether they are worth carrying on with in 1930 or not. Some of them appear to have excellent yielding

capacity, and if they prove thoroughly resistant to stem rust, of which I am by no means certain, they should be of great value, unless, when grown in large plots, their straw proves too weak. I have mentioned this, because the problem of strength of straw is almost as important in this country as is that of resistance to stem rust. Unfortunately, weakness of straw does not readily show itself either at the Njoro Plant Breeding Station or at the Scott Agricultural Laboratories, but as soon as wheats are transferred to some other districts where soil and growing conditions are extremely good many, hitherto considered strong strawed, show a tendency to lodge when grown in fair sized plots. These families already referred to may display this character elsewhere as their straw is rather long even at the Scott Agricultural Laboratories.

The natural hybrids found in B. 286 which are now apparently in the F_2 or F_3 generation are extremely promising, the straw of most of the plants is short and appears strong, and the ears contain more grain than do those of B. 286, whilst the grain itself is generally of better appearance. Whilst some plants were severely attacked by stem rust, others showed no signs of it at all. These natural hybrids are undoubtedly the progeny of B. 286 crossed by some other wheat or wheats.

The F_2 generation from the crosses referred to in my annual report for 1928 was sown in the cage and many promising plants have been harvested. There was an extremely severe infestation of stem rust throughout these cultures (the physiologic form present being that known as K1), so that those plants which were not attacked can be regarded as possessing resistance to this form, though they will not all necessarily be resistant to form K2. Naturally, for example, there was practically no stem rust seen in families from the cross B. 286. A. by B. F_2 . 36 C. 1. (L), because the parent susceptible to stem rust is only susceptible to form K2. As form K2 has appeared during the short rains season of 1929 it is unfortunate that it was found impossible to grow the selected plants during those rains, as they would by now have displayed their resistance or otherwise to this physiologic form. Most of the plants selected out of the families from the crosses made with Red Egyptian have been sent up to the Njoro Plant Breeding Station for further trial, as they take too long to mature for conditions at the Scott Laboratories.

The other three were physiologically resistant to form K1 and moderately susceptible to form K2. Shortly after this was discovered a very severe infection of stem rust appeared in

the field, and these three wheats were completely destroyed by it, thus showing that form K2 was present, whilst B. F₄ 2. D. 30. B. 2. (L) and incidentally B. 286 were completely free from it. This occurrence completely demonstrates the value and in fact the necessity now of this inoculation work to minimise and clarify one side of plant breeding work, as none of these three wheats had in previous years showed other than the very slightest signs of stem rust. Nevertheless, they and many other wheats have been needlessly kept going for years.

During the long rains of 1929 three high yielding strains of wheat were crossed with B. 286 with the idea of improving its yielding capacity. The F₁ generation was sown during the short rains.

In the short rains season of 1929 crosses were made between B. 286 and a type of wheat found in Australian Florence. This type in Florence, whilst susceptible to stem rust, is immune to yellow rust. The reason for making this cross will appear later on in this report.

As foreshadowed in my annual report for 1928, an experiment was laid out in 1929 to determine whether there was any difference in yield between B. 286 and the pure line strain B. 286 C., also as to how the yield of these two wheats compared with that of Kenya Governor, whose yielding capacity is well known. The experiment consisted of four three-sided ratin squares, each individual plot being four feet square. There were six rows eight inches apart in each plot and forty grains were sown in each row. There were no gaps between plots but lengths of wire were laid down between plots at sowing time so as to be able to separate them at harvest. Wheat was sown closely all round the area so as to prevent border effect occurring in the outside plots.

On working out the results of the experiments statistically it appeared that the yielding capacity of B. 286 was 80 per cent of that of Kenya Governor. There was no significant increase in yield of B. 286 C. over B. 286. There were merely indications that B. 286 C. was a slightly higher yielder, and the experiment was therefore repeated during the short rains of 1929. Results of this experiment are not yet to hand.

Njoro Plant Breeding Station.

The rains came very late this year, the real rains starting on April 31st. Instead of following the usual practice of sowing wheat in June, so that it gets the benefit of the July-

August rains, and not much benefit but often harm from the October-November rains, the wheat was sown, as indicated in my annual report for 1928, early in May, so as to obtain the benefit both of the May rains and the July-August rains. It was harvested in September, which is usually a fairly dry month. Only fourteen inches of rain fell during the period of growth, and yet B. 286 yielded ten bags to the acre, and another wheat fourteen bags. In a somewhat similar year, namely in 1928, wheat (Kenya Governor) was sown in June and only yielded about four bags to the acre. It is considered that this great increase in yield is due not only to the increase of rainfall, but also to the wheat having enjoyed the benefit of growing during the real "growing season." It has been my opinion for some time that the growing season starts with the first real rains that fall after the dry months of January, February and early March, and therefore that all crops should if possible be sown as soon as the first real rains fall, because the land is warm and the crops come away in a much better manner. In districts, however, where September is not fairly dry, a "four months" wheat cannot be sown at the optimum time.

Large numbers of hybrid families of wheat, mostly of the F_2 generation, were grown. Most of these wheats originated from Kabete and the Scott Laboratories. Several cultures came true to type at last, and were extremely promising. Steps have been taken to have them inoculated with stem rust before the sowing season of 1930.

The F_1 generation of the crosses made in 1928, and referred to in my report for that year, were grown in the cage.

A number of crosses were made between some of the Njoro types of wheats, which are resistant to stem rust, and Marquis.

The idea of these crosses is to improve the milling quality and straw of the Njoro wheats. Two other wheats which have been bred by myself were also used for this purpose. Both Marquis and the other two wheats are susceptible both to stem and yellow rust, and so the progeny of these crosses will only be useful for medium and low altitude districts with a prolonged rainfall, i.e. not for such districts as Machakos. They should yield considerably higher than a very quick maturing wheat such as B. 286. Crosses were also made between B. 286 and some of the Njoro types of wheats, with the object

of combining the good qualities of both. Both parents are resistant to stem rust. The same type in Florence wheat, to which reference has already been made, was crossed with some of the Njoro types of wheat in order definitely to obtain a fairly long maturing wheat resistant both to stem rust and yellow rust, and suitable for the large wheat-growing areas at the higher altitudes of the Colony.

Crosses with a similar purpose were made in 1928 between Equator and some of the Njoro wheats.

Another interesting cross was made between Equator and a wheat called Kanred. Kanred was bred in America, and is highly resistant to both forms of stem rust, but takes much too long to mature. In fact the Kanred sown early in May only came into ear at the end of January. Equator, as is well known, is susceptible to stem rust, but immune to yellow rust.

Trial Plots.

One hundred and forty-four strains of Njoro wheats, which were described in my annual report for 1928, were grown in quadruplicate in trial plots, for observation purposes; a further 144 strains of a special Njoro type and of some wheats bred at the Scott Agricultural Laboratories were sown in trial plots in duplicate. This total of 864 plots, each twelve feet long and four feet wide, was accurately sown by hand. This was the final trial of the original Njoro wheats. Almost all of them have now been inoculated by the Mycologist, and their resistance to stem rust is definitely known. They all appear to do extremely well at Njoro, and except for differences in resistance to stem rust many of them differ only in such characters as beardedness, chaff colour and grain colour, so that those of them which are resistant to stem rust can now be bulked in groups, except where there are differences in resistance to yellow rust.

Very little stem rust was in evidence this year at Njoro, even amongst the susceptible wheats which were grown as testers. As regards "testers," three sorts are used: some are susceptible to both forms of stem rust, other are susceptible to K1 and resistant to K2, and others are susceptible to K2 and resistant to K1, so that, if rust appears, we know which form is present.

Several imported wheats were tried, including Black Hull, Turkey Red, Defiance, Escondido, and Reliance. The first two took far too long to mature, and all the rest, except

Reliance, were susceptible to stem rust. This wheat Reliance was sent to the Mycologist by his collaborators in the United States of America, because according to their experiments it should prove resistant to both physiologic forms of stem rust present in this Colony. Similar tests made by the Mycologist confirmed this result. At Njoro the wheat grew extremely well, and it is a bearded wheat with a plump red grain. It showed no signs of stem rust, but was very susceptible to yellow rust. It took longer to mature than such wheats as B. 286 and Kenya Governor, but should be valuable for low altitude districts with a prolonged rainfall. A request has been sent to America to send the Department as much as they can spare up to 200 pounds.

Yield Trial Experiments.

It was decided this year to compare accurately the yielding capacity of three types of Njoro wheats with themselves and with B. 286. The experiment was laid down in the form of four-sided latin squares, the plots in each of which were randomised; there was a total of sixty-four plots, each plot being four feet square. The experiment was in fact similar in design to the one done at the Scott Agricultural Laboratories. As regards the Njoro wheats, one of them was the ordinary type, with rather a tapering ear, the second was a special one of a similar type, but with a more square headed ear, and the third was a compact-eared wheat, commonly known as a club wheat. The mean yield given by B. 286 was at the rate of 10.78 bags to the acre, the mean yield of the first Njoro wheat was 18.68 bags to the acre, that of the second Njoro wheat 18.59 bags to the acre, and of the club wheat, 14.0 bags to the acre. All the increases in yield over B. 286 were significant, as was the difference in yield between the first two Njoro wheats and the club wheat. As the yielding capacity of B. 286 in the field is not well known, the results of this experiment should be examined in relation to the results obtained from the experiment at the Scott Agricultural Laboratories, where the yielding capacity of B. 286 was compared with that of Kenya Governor. In this way the probable yield in the field of the Njoro wheats can be estimated.

Mau Summit Plant Breeding Station.

After the experience of 1928, it was decided to use Mau Summit solely as a testing place for yellow rust. At high altitudes it is now as important as it is anywhere else to use only wheats which are resistant to stem rust and they must in addition be resistant to yellow rust.

A large number of wheats which are resistant to stem rust were therefore tested in the cage there this year, and observations made on the resistance to stem and yellow rust. The wheats used were as follows :—

219 of the new Njoro wheats.

77 wheats bred at the Scott Laboratories.

121 F_2 families sent by Sir Rowland Biffen.

11 types of wheat chosen from those selected out of the Australian Florence in 1928.

8 Durum wheats.

A few American and Australian varieties (i.e. those tried at Njoro).

A number of rust testers were also sown, making a grand total of over 450 wheats.

It was found that, contrary to all previous expectations, whilst all the Njoro wheats considered resistant to stem rust were so, yet most of them proved too susceptible to yellow rust to be of use for high altitudes. The number of spikelets in the ears infected by yellow rust varied in the different wheats from 10 per cent to 80 per cent. Ten per cent is considered too high an infection in small plots, as experience elsewhere shows that such an infection can be greatly increased in larger plots. One group of wheats, however, while fairly attacked on the leaves, only showed a 1 per cent infection in the ears, and hopes were entertained of the wheats in this group. Unfortunately, one of this group which was being multiplied by a farmer near Timboroa on an exposed ridge at an altitude of about 9,000 feet, was found on inspection to be severely infected with yellow rust. This observation indicates that none of the wheats in this group are sufficiently resistant to yellow rust, in spite of their behaviour at Mau Summit, and that the station at Mau Summit (8,500 feet in altitude) does not always provide a sufficiently severe test for this rust. There was one other group of wheats, however, and about half a dozen other wheats which showed a smaller infection still of yellow rust. The group of wheats referred to consisted of club wheats. One of these was being multiplied by a farmer near Thomson's Falls at an altitude of about 9,000 feet. An inspection of this wheat revealed no signs of yellow rust nor of stem rust. One of the other wheats referred to was being multiplied by another farmer near Thomson's Falls at an

altitude of about 8,500 feet. When inspected the wheat had only been in the ear for about three weeks, but showed not a vestige of either yellow or stem rust. Again, another of these wheats was being multiplied by a farmer in Upper Gilgil at an altitude of about 8,500 feet. On examination, the infection of yellow rust was found to be about 10 per cent in the ears, whilst next door to it another Njoro wheat which had an infection at Mau Summit of about 20 per cent, showed an infection varying from 50 per cent to 80 per cent.

It would appear therefore that a few at any rate of the Njoro wheats may prove satisfactory at high altitudes.

None of the seventy-seven wheats bred at the Scott Agricultural Laboratories proved sufficiently resistant to yellow rust at Mau Summit to be of use there.

The eleven types selected from Australian Florence which were grown at Mau Summit this year were the best of the twenty-four types selected in 1927. They were sown again this year to receive a further test for resistance to yellow rust. They were all completely immune, though all but one were badly attacked by stem rust. This particular type must have been a natural hybrid, and was segregating this year. All the plants in the culture were only lightly attacked by stem rust, and the grain was not affected. The plants were separately harvested, and will be grown on separately again next year in the hope that something useful may be found amongst Florence for early use at high altitudes. All the Florence types referred to grew well and appeared suitable for conditions at these altitudes.

The F_2 families sent out from Cambridge were bred by Sir Rowland Biffen for resistance to yellow rust only, because when he visited the country in 1926, stem rust was not considered a menace to high altitudes, and therefore it was only thought necessary in those days to produce wheats resistant to yellow rust for use in those districts. The situation since then has completely changed, as is well known. Whilst these families were mostly resistant to yellow rust—for which they were bred—they were all very susceptible to stem rust. One or two of them which grew outstandingly well should be useful for crossing purposes.

All the Durum wheats were susceptible to both stem rust and yellow rust. These were: Beliss, Acme, Kahla, Nodak, Kubanka, Pentad, Bontaar and Golden Ball.

The New Wheat B. 286.

The origin of this wheat was given in my annual report for 1928. It is a beardless white-grained wheat. Though not quite pure in some botanical characters, the grain is of the same type throughout. The impurities in it have proved impossible totally to eradicate, as they did not appear until the wheat was in some bulk. They seem to be the progeny of considerable natural crossing, the results of which would not necessarily be seen until the second generation. Pure seed of B. 286 can be obtained by selecting single plants and starting off fresh seed from plants which breed true to B. 286 type.

B. 286 has some outstanding characters. It is, generally speaking, a strong strawed wheat compared with Kenya Governor. It is only when grown on very strong soil under good growing conditions that it grows as high as five feet or more and falls down. This weakness is displayed, not in the straw itself, but at the junction of the root and stem. As a compensation for this it yields under these circumstances as much as fifteen bags to the acre. Under ordinary circumstances, such as under conditions where the straw grows to about four feet high, it yields from eight to ten bags to the acre.

This wheat also possesses very close chaff which prevents any loss of grain from shedding when ripe. It has already been stated that its yielding capacity is about 80 per cent that of Kenya Governor. By comparative yielding capacity is meant that when small plots of each are grown and harvested carefully by hand, so that no shedding takes place, Kenya Governor would yield more than B. 286. When, however, large acreages of both wheats are grown, and a harvester-thresher is used to harvest the crops, so that the characters of shedding and weak straw possessed by Kenya Governor become decisive factors in lowering its yields per acre, then B. 286 should yield as or more highly per acre than Kenya Governor usually does. This is apart altogether from losses incurred by attacks of stem rust.

As regards stem rust resistance, there is no comparison between the two wheats. B. 286 is highly resistant both physiologically and in the field to both physiologic forms of stem rust, whereas Kenya Governor is highly resistant only to one and is moderately susceptible to the other. This susceptibility has been apparent in several instances during the last two years, though fortunately no great damage has been done and Kenya Governor has thoroughly justified the purpose of

its existence, which was that of a stop-gap, until better wheats were produced. B. 286, though more resistant to yellow rust than Kenya Governor, is unfortunately not sufficiently resistant to be grown at the higher and colder altitudes of 8,000 feet and over.

It is somewhat unfortunate that B. 286 is very susceptible to leaf rust. If a very severe infection takes place at an early stage in the growth of the plant there is likely to be some reduction in yield, but nothing like total destruction of the crop could possibly occur.

As regards the milling and baking qualities of this wheat, a small quantity was sent last year to Sir Rowland Biffen at Cambridge, who kindly undertook to make certain tests for these qualities.

He reported that its baking qualities were very satisfactory, and that they could be considered better than those of English wheats. The gluten, though of good quality, was not so elastic as that of some wheats imported into England. He was pleased with the appearance of the grain. In this country we are accustomed to wheats with a very plump appearance, and a bushel weight higher than the average, so that I was somewhat doubtful of the quality and value of B. 286 with its bushel weight of only 60 lb. and wide deep crease. My fears have fortunately turned out to be groundless, although the bushel weight of the wheat will seldom put it into the local first grade as grades are at present constituted. There are, however, ways of overcoming this anomaly.

Further preliminary tests have been made by Messrs. Unga, Limited, who milled a 200 lb. bag of the grain. Tests of the strength of the flour gave a figure of 49.5, which is equal to that of the best Manitoba. The water absorption capacity of the flour was considerably higher than that of Kenya Governor-Equator flour. The texture of the loaves made from it was excellent, and they rose an inch or so higher than loaves made from ordinary local flour. On account of these qualities the wheat should be of the greatest value to the local milling and baking trades, and should make the wheat of more value for export than either Kenya Governor or Equator.

This wheat will in future be called "Kenya Standard." The price per bag of 200 lb. of seed has been fixed at Sh. 25/62 for the year 1930, and there are approximately 4,500 bags available for sowing in that year.

*General Remarks on the Present Position of
Wheat Breeding.*

When I first came to the Colony in 1921 the main problem was to produce a wheat or wheats resistant to stem rust for districts from about 4,500 feet to 7,000 feet in altitude. This has now been accomplished by the production of B. 286, of which sufficient is now available to sow up some 13,000 acres. In this connexion the acreage under Kenya Governor (which is the wheat now grown in these districts) was last year about 18,000 acres. Several years after I arrived in the Colony the main scene of wheat-growing began to shift more and more towards the higher altitudes of the Colony, such as Upper Molo, Mau Summit, Kipkabus, Upper Gilgil and Thomson's Falls. The acreage under wheat in these areas last year was about 50,000 acres. This large acreage was put under wheat on the idea that Equator was a safe wheat to grow on account of its immunity to yellow rust. Its susceptibility to stem rust was not considered of importance as, until 1927, stem rust had never appeared at these altitudes. Since then, as is well known, stem rust has become increasingly malignant, and Equator has for some time not been a safe wheat to grow. It has been thought by myself and others that the wheats which have been bred by me at Njoro would take the place of Equator, on account of the resistance of some of them to both stem and yellow rust, and that they would be in sufficient bulk for general use by 1932 at least. The position is now, however, more doubtful.

Although yellow rust occurs to a sufficient extent at Njoro to prevent many varieties of wheat being grown there, yet it has been found not to be a sufficiently severe testing place for the resistance of wheats to the rust at higher altitudes. So that whilst a number of wheats have been bred at Njoro which are infinitely more resistant to yellow rust than are the majority, yet most of them have this year been proved to be by no means sufficiently resistant to this rust at the highest altitudes. There are still a few, however, to which reference has already been made, of which hopes are entertained. Some of these have already been multiplied by farmers, and others will be issued for multiplication in 1930. As a matter of fact, some eighty of the Njoro wheats had reached the stage this year when they were in sufficient bulk to be issued to farmers for further multiplication, whilst the final tests on them were being made by the Mycologist and myself. They were issued early in the year in quantities varying from 2 lb. to 50 lb. each.

The seed remains the property of the Agricultural Department until it is released for general issue by the Director. The price of seed is fixed at Sh. 25 per bag. As a result of these issues much valuable information has been gained as to their behaviour under varying conditions in different parts of the Colony. Farmers who were given wheats which have failed to withstand the final tests have been told to destroy what grain they had.

The club wheats, if they continue to show resistance to yellow-rust, should be valuable. They are all highly resistant to physiologic form of stem rust No. K1, but susceptible to K2. This susceptibility detracts to a certain extent from their value. It must be remembered, however, that Equator is not always damaged by stem rust at the higher altitudes, though it is very susceptible to both physiologic forms. These club wheats have been exposed at Njoro to very severe infection by stem rust for several years. Although this rust has sometimes been found on them it has never damaged them, whereas Equator is invariably destroyed by it at Njoro. These observations indicate that the club wheats may temporarily solve the problem of wheat-growing at the higher altitudes, as did Kenya Governor at the lower. Of the other wheats specially resistant to yellow rust, of which two were multiplied near Thomson's Falls and Upper Gilgil last year, one of them should, if it maintains its resistance to yellow rust, be more valuable at the higher altitudes than the club wheats, as it is resistant to *both* physiologic forms of stem rust. Another drawback to Njoro wheats, which has only been discovered this year, is that, when grown on fair-sized areas at the higher altitudes, they are inclined to lodge; not only is the straw somewhat weak, but they produce a large amount of foliage, which causes them to suffer more from storms of heavy rains and high winds than wheats with less foliage. These facts about the Njoro wheats were not discovered until they were in sufficient quantity to be grown in fair bulk at higher altitudes than Njoro and in situations other than that of the Plant Breeding Station at Mau Summit.

In the meanwhile, in order to produce wheats certain to be resistant to both stem and yellow rust, crosses were made in the past between Equator and some of the Njoro wheats considered to be the most resistant to stem rust. It was an unfortunate coincidence that these Njoro wheats are some of the very ones that have broken down under the Mycologist's inoculation tests to one form—though the one

form only—of stem rust. These wheats have never been infected by stem rust in the field, wherever grown, but nevertheless they cannot now be considered the best material to use as parents for crosses.

It may be stated here that the whole situation has been aggravated in the past by the lack of continuity in plant breeding services, as otherwise, if the original parentage of these wheats had been definitely known, it would have been known for certain whether any of the progeny could show complete resistance to any or all of the rusts present in the Colony.

The situation is now completely and most favourably altered. The staff at the Plant Breeding Services is increased and continuity assured. We know definitely at last which of the locally bred wheats are resistant to both physiologic forms of stem rust. In Equator and some of the types discovered in Australian Florence we have wheats which are immune to yellow rust. Crosses made between these wheats should produce varieties of wheat, both long and short maturing, suitable for and resistant to all rusts in every district of the Colony. Immunity, not merely resistance, to yellow rust will be sought. These crosses were made this year. The progeny of the cross between Florence and B. 286 will be grown twice a year at the Scott Agricultural Laboratories, so that results may be available to farmers in the shortest possible space of time. In the case of the crosses made with Njoro wheats, it will be some years longer before results are available to farmers, as only one season in the year can be used to propagate such wheats, on account of their comparatively long maturing habit.

It may be of interest to the Department and to farmers at the higher altitudes to know that a kind of barley called Nepal, or naked barley, has been grown with success at Upper Gilgil this year. This barley is a six-row barley with short hooded awns and grain which threshes out like wheat. The grain can be either black or yellowish white, and weighs over 60 lb. to the bushel. A sample of this was sent to Europe, and Sh. 4 a quarter more was offered for it than for ordinary feeding barley, though it had apparently never been seen on the European market before.

MAIZE BREEDING.

The maize breeding work begun in 1928 was continued in the ordinary way at Njoro this year. Three breeding plots were planted with three different types of selected maize seed

from the three main breeding plots of last year. Five other breeding plots were planted up with the remainder of the seed from the cobs which showed up best in the ear-to-row tests of 1928.

These five plots were each surrounded by seed from the next best cobs of the same type to exclude foreign pollen as much as possible.

Plants were selected during the year throughout these breeding plots, and the best cobs from them have now been chosen. The three main breeding plots will be planted up again with the seed selected this year. Of the five smaller breeding plots, one showed up much better than the rest, and seed from that one only will be propagated next year. It is too early yet to say to what extent the seed has improved, or to say whether any one type is doing better than any other.

An area of some five acres was planted with seed from the Kenya Flat White maize previously bred at the Scott Agricultural Laboratories, in order to see whether improved seed could be obtained from it in spite of the failure of selected cobs of this type in the ear-to-row tests made at Njoro in 1928. This maize has shown itself to more advantage this season perhaps because the planting was more widely spaced than in the case of the checked-row breeding plots. Selection was carried out in the field, and a number of long heavy-yielding cobs with a row number round about twelve have been picked out. It is possible that a heavy-yielding strain may be worked up from these selections. A few of the cobs weigh well over a pound, which is quite unusual under conditions experienced in this part of Njoro.

In order to provide a sound basis for improvement of maize seed, further ear-to-row tests were made this year, and the cobs used, of which there were 168 in number, had mostly been selected in the field at the Plant Breeding Station. The majority of them were good cobs, but a few were nubbins, which were grown on in order to see if they produced equally poor cobs. In order to obtain accuracy of results every third row was planted with ordinary seed maize as a control. Owing, however, to a very severe infection of ear-rot, amounting in some rows to 50 per cent and in others to 5 per cent, it was quite impossible to place any reliance in weighings. The cobs harvested from each row were examined, and the four rows which contained the best-looking and heaviest cobs were chosen for further breeding purposes—actually, of course, it

will be the seed left over from last year which will be used for this purpose. Two of the cobs chosen for propagation produced a majority of cobs of a flinty type, which seems to be the type most suited to Njoro. The other two cobs produced a large proportion of dent cobs of a heavy yielding kind.

Results showed that a nubbin does not necessarily produce nubbins, and that a cob with twisted rows does not necessarily pass this character on to its progeny. In the case of two of the nubbins, the rows from them gave yields 50 per cent and 60 per cent higher than the control rows adjoining them; furthermore, the cobs in the rows were of larger and better appearance than those in the control rows. The cobs were in fact above normal in size and appearance. These observations illustrate the point which has been made in a pamphlet recently written by me on maize breeding, in which I stress the importance of selecting cobs for healthiness and vigour rather than for "show" points. By selecting on these lines, losses from such diseases as white blight and ear-rot should be greatly minimised.

Where selection in the field is practised, farmers should choose healthy, vigorous and productive plants with large ears well covered at the tips by the bracts (i.e. sheath), which should fit closely over the cob which itself should hang over some time before it yellows off without the shank being unduly long. Any other considerations beyond these here mentioned are entirely secondary. If the tips of the cobs are well covered by the bracts it is more difficult for disease to enter. If the bracts are close fitting all over the cob water is not so likely to enter between the bracts and so cause disease. Similarly, if the cob hangs over, water will the more easily run off it, and enter neither at the tip nor between the bracts.

Coming now to the selection of cobs the important points are :—

- (1) To choose only cobs which are completely free from disease.
- (2) To choose the heaviest cobs.
- (3) To choose the longest cobs.
- (4) To choose cobs whose grain is thick.

All other points, such as well-covered butts and tips, narrow sulci, etc., in short, "show points," are entirely secondary, and indeed of little if any value, as such qualities are not passed on to the progeny.

Breeding for a particular row number is inadvisable, as too much inbreeding, resulting in lack of vigour, would have to be practised. Cobs with a low row number usually yield best, but the row number should not be lower than ten. It is best to choose cobs of from ten to fourteen rows. Cylindrical cobs do not necessarily produce progeny with cylindrical cobs. When cobs are found satisfying the four above-mentioned qualities it is advisable to choose the deeper-grained ones. Again, so long as the chosen cobs satisfy the selector in the four important points, it is considered that the type or types of whatever appearance most suited to any particular soil and climate will almost of themselves become predominant in a crop. To retain vigour maize must be well cross-bred, so it is wrong to breed too much artificially to one type and one only.

It will be of interest to mention that 21,168 plants were grown in the ear-to-row plot, that only 16,235 of them bore cobs, i.e. a loss of 23.3 per cent, and that of these cobs 20 per cent were destroyed by ear-rot. This means that the large percentage of 38.7 per cent of cobs was lost through these two causes alone. These observations again show the importance of using only the most healthy and vigorous seed available.

In the light of the experience of the last two years, it is somewhat doubtful whether maize breeding at Njoro is going to be successful in the respect that large cobs are never grown under the climatic conditions obtaining there.

In the first place therefore some of the selected seed grown there will be tried out in 1930 in the Solai Valley, which is at a much lower altitude than Njoro. It is possible that the small cobs grown at Njoro will do very much better down there, and even better than the maize usually grown in and acclimatised to the Solai Valley. In the meantime also the maize breeding plots at Njoro will be situated in 1930 near the irrigation reservoir, so that the plots can be irrigated if necessary. Both farmyard manure and phosphates will be applied to the plots. If better cobs are the result, and the seed sent down to Solai is successful, then maize breeding can be continued at the Njoro Plant Breeding Station.

White Blight.

In 1928 maize plants showing very little signs of this disease, though surrounded by heavily infected plants, were selected in the field. This year, half the grain from each selected cob was grown in two series of ear-to-row tests in the

Trans Nzoia. Every sixth row was planted with grains from cobs taken from heavily infected plants. The plots were planted by the Agricultural Officer for the district at Elgon Downs Estate (through the courtesy of Mr. Barber) and at Sabwani Estate (through the courtesy of Estates and Investments, Ltd.). The ear-to-rows were examined several times during growth, and the rows planted with seed from infected plants were so outstandingly inferior that they could easily be picked out by any one not knowing the sowing plan. The plants in these rows were badly infected with "white blight," and were feeble and stunted in appearance. The plants in the other rows were vigorous and productive, and only showed slight signs of the disease.

These outstanding results can be dependent on either or both of two factors :—

- (1) The freedom from disease in the rows from selected plants was due to the extra vigour of plants grown from healthy, vigorous seed produced by healthy, vigorous plants.
- (2) The freedom from disease was hereditary, i.e. the control rows were poor because they were susceptible to the disease and the plants again contracted it, whereas the selected rows were good because the plants were resistant to the disease and therefore did not succumb to it.

If comparative freedom from this disease is due only to vigorous seed obtained from fairly healthy plants, then all a farmer can do is to obtain seed from farms which were unaffected by "white blight," in order to stand a fair chance of growing a healthy crop. If, on the other hand, there is such a thing as hereditary resistance to the disease the only way to guard against it is to choose seed from only slightly infected, or uninfected plants, growing amongst a healthy infected crop.

Experiments will be conducted in the Trans Nzoia in 1930 designed to determine whether hereditary resistance to the disease exists in some maize plants or not. In any case the remainder of the seed on the cobs from the "resistant" plants chosen in 1928 will be sown this year, so that if hereditary resistance is shown to exist a stock of resistant seed will be available.

EXPERIMENTAL WORK AT NJORO PLANT BREEDING STATION.

The experiments began in 1928 and were continued this year with certain alterations which will be described. All the experiments have been designed in such a way that they are interdependent, and it is considered that they are such as will give the farmer valuable information at an early date, and indeed some of them have, as will be seen, given useful and informative results already.

Temporary Strip Experiment (Phosphates).

This phosphatic experiment was repeated this year. The treatments applied were the same as last year, except that no fertiliser was applied to the last four plots, the object being to ascertain as far as possible whether any obvious residual values remained. None were observed.

The application of phosphates again gave obvious results. The superphosphate and Ephos treatments in particular were outstanding. In these plots the wheat grew more vigorously and ripened earlier than the controls, and obviously gave higher yields. There is no object in giving the actual yield of the different treatments, although their yields as well as those of the controls were taken, because a strip experiment, by its very nature, is only an observational one, and not accurate enough for any other purpose. Accurate results were obtained from the chessboard experiment, which was designed in such a way as to give them. This strip experiment proved of great interest to every farmer visiting the station.

Temporary Strip Experiment (Potash and Phosphates).

The above experiment was laid down because it is sometimes thought that the good results received on patches of soils where maize stalks have been burned was due to the potash, and because it would be interesting to see whether as small an application as 60 lb. of superphosphate per acre gave adequate results.

A strip 153 yards long and 20 yards broad was seeded to wheat. The strip was divided into plots, each 9 yards by 20 yards.

There were four treatments, with controls left between each treatment. The treatments were as follows :—

- (1) Fertilised with superphosphate at 60 lb. per acre.
- (2) Fertilised with potash (muriate) at 50 lb. per acre.
- (3) Fertilised with superphosphate and potash at 100 lb. and 50 lb. per acre respectively.

(4) Fertilised with superphosphate at 100 lb. per acre.

The experiment was duplicated.

The potash treatment showed no results. The plots treated with superphosphate were outstanding, and the plots treated with 60 lb. per acre appeared to be as good as those treated with 100 lb. and as good also as those treated with 130 lb. or 150 lb. in the other strip experiment.

*Temporary Strip Experiment—Lime and Phosphate
on Maize.*

This experiment, begun in 1928, was repeated this year. In common with the phosphate and potash strip experiments on wheat, it was laid down for observational purposes only. The phosphatic fertiliser used was Seychelles guano at the rate of 150 lb. to the acre. The ground limestone was applied again at a rate of half a ton to the acre.

The plots treated with guano and with lime and guano were obviously much better than the controls. The plot treated with lime alone appeared no better than the controls.

The plots were harvested and weighed and confirmed the observational results. The plots treated with guano and with lime and guano yielded at least 25 per cent better than the controls. Too much reliance must not of course be placed on these figures, as the experiment was only a strip one. Every row, however, in the treated and control plots was harvested and weighed separately to see if there was any great variation in yields within each plot. There turned out to be very little variation in yields between single rows in any plot, so that the actual yields and increases in yield do have some value and are therefore in this case given, and are as follows :—

(1) Control	...	...	...	11.79
(2) Lime	...	...	...	11.79
(3) Control	...	...	...	11.29
(4) Lime and guano	...	...	...	16.13
(5) Control (this was a bad patch of soil in a slight depression)				10.38
(6) Guano	...	...	...	15.5
(7) Control	...	...	...	12.29

Humus Experiment.

This experiment was laid down to discover how often it is advisable to introduce a green manure into a rotation.

Half an acre of land was divided into sixteen plots, so that each treatment was replicated four times and the plots were randomised.

The half-acre was seeded with wheat this year. After harvest green organic matter was carted to the spot and ploughed into twelve of the plots. The green matter used was sunflowers, and they were grown on plots of the same size as those which composed the experiment. The sunflowers were pulled off each plot by the roots and carried over to the corresponding plot on the experiment and ploughed in. On four plots this will be repeated every third year, on four every fourth year, and four more every fifth year, the remaining four plots remaining as controls. The weight of green matter applied to each plot was at the rate of about 15 tons per acre. In order to obtain the best results from the experiment it may be necessary to fertilise *all* the plots with phosphates next year. By applying organic matter in this way it should be possible to obtain results from the experiment quicker than by actual green manuring, though not quite the same benefit will be obtained as from an actual green manure, particularly a legume.

Chess Board Manurial Experiment.

This experiment was slightly altered this year. The whole area was arranged to take the form of two four-sided latin squares, so that instead of the 28 plots laid out last year, 32 plots were laid out, each plot being 18 yards by 20 yards, with a four-foot border planted up with wheat between each plot and around the outside plots.

The experiment was divided into two sections, each containing sixteen plots, and in each section there were six treatments and four controls. The plots in each section were separately randomised and each treatment was replicated twice.

Last year no fertiliser was applied to any portion of this area, so that the alteration in the size of plots, though increasing the area slightly, by no means interferes with the accuracy of the experiment, which in point of fact will give more accurate results in its present form.

The treatments were as follows :—

- (1) Lime.
- (2) Phosphate.
- (3) Lime and phosphate.
- (4) Nitrogen.
- (5) Potash.
- (6) Organic matter (not applied).

Lime was applied at the rate of half a ton of ground limestone per acre, superphosphate at the rate of 130 lb. per acre, nitrogen in the form of sulphate of ammonia, and potash in the form of muriate of potash, each at the rate of 50 lb. per acre.

The experiment was seeded with the wheat B. 286, and the results obtained were as follows:—

					<i>Mean yield—bags per acre.</i>
Controls	...	...	...	...	9.
Phosphated plots	...	...	...	...	10.16
Limed and phosphated plots	...	...	...	...	10.07
Nitrogen plots	...	...	...	...	8.7
Potash plots	...	...	...	...	8.9

Sunflowers were grown on separate plots of the same area to provide the organic matter. After the wheat was harvested this organic matter was transferred to the plots receiving this treatment. The rate of application was 15 tons of green matter to the acre.

On working out the results of the experiment it was found that the increase in yield of one bag per acre given by the phosphated and limed and phosphated plots was significant. The other treatments gave no results.

As a matter of interest the actual yields obtained from the plots are given. They have been converted into bags per acre.

YIELD OF THE PLOTS—CONVERTED INTO BAGS PER ACRE.

Controls	Humus	130 lb. Super- phosphate	$\frac{1}{2}$ ton Lime	Lime and Super- phosphate	50 lb. Muriate of Potash	50 lb. Sulphate of Ammonia
8.5	9.95	11.00	8.3	10.3	8.9	7.7
9.5	8.8	9.95	9.5	10.95	8.5	9.7
9.2	8.45	10.00	8.7	10.05	10.5	8.2
9.55	8.25	9.7	8.5	9.00	7.8	9.3
9.1						
8.95						
8.5						
9.2						

1	2	3	4	5	6	7	8
Humus	Lime	Nitrogen	Control	Lime & Super-phosphate	Control	Potash	Super-phosphate
9.95	8.3	7.7	8.5	10.3	9.5	8.9	11.00
9	10	11	12	13	14	15	16
Control	Super-phosphate	Lime	Lime & Super-phosphate	Nitrogen	Potash	Control	Humus
9.2	9.95	9.5	10.95	9.7	8.5	9.55	8.8
17	18	19	20	21	22	23	24
Control	Nitrogen	Lime & Super-phosphate	Potash	Lime	Humus	Super-phosphate	Control
9.1	8.2	10.05	10.5	8.7	8.45	9.7	9.2
25	26	27	28	29	30	31	32
Super-phosphate	Control	Control	Nitrogen	Potash	Lime & Super-phosphate	Humus	Lime
10.0	8.95	8.5	9.3	7.8	9.00	8.25	8.5

Plots 29, 30, 31 and 32 suffered from the effect of poorer ploughing treatment than last year.

The necessary organic matter having now been ploughed in, the experiment can next year be carried out in the form detailed in my annual report for 1928.

Crop Trial Experiments.

Crop trials of cereals were continued again this year at Njoro. All crops were planted early in May, so as to obtain the benefit of the growing season.

One-third of an acre each was sown with wheat, barley, rye and maize on unfertilised land and a further one-third of an acre of each crop on fertilised land.

The wheat used was a new wheat numbered B. F₂ 36 C.1 (L), and the barley was a two-row Archer barley.

On the unfertilised land two one-third acres of maize were planted, one being an even stand, and the other a ragged one.

The yields per acre were as follows :—

Fertilised Land.

Wheat gave 13.87 bags of 200 lb. net per acre.

Barley gave 17.00 bags of 180 lb. net per acre.

Rye gave 11.00 bags of 200 lb. net per acre.

Maize gave 10.8 bags of 200 lb. net per acre.

Unfertilised Land.

Wheat gave 13.5 bags of 200 lb. net per acre.

Barley gave 15.0 bags of 180 lb. net per acre.

Rye gave 10.0 bags of 200 lb. net per acre.

Maize (even stand) gave 13.0 bags of 200 lb. net per acre.

Maize (ragged stand) gave 9.0 bags of 200 lb. net per acre.

The results of this experiment indicate that wheat, when grown at the proper time of the year, is the best and most profitable cereal to sow at Njoro. The yields given by B. 286 in the chessboard manurial experiment should be considered as well as the yields given by B. F₂ 36 C. 1 (L) in this crop trial experiment.

B. 286 yielded nine and ten bags to the acre on unfertilised and fertilised land respectively.

The soil at Njoro proved too good for rye, which lodged badly.

Although in all experiments the use of phosphates did not give greatly increased yields, yet the fertilised crops were always more vigorous and healthy than the unfertilised, and were more capable of withstanding adverse conditions. On soils in poorer heart than that of the Plant Breeding Station phosphates have greatly increased the yields of wheat.

It is interesting to note the greatly increased yields given by wheat and barley over the yields obtained in 1928, when these crops were sown in June instead of early May.

The results of these important crop trial experiments will be discussed in an article which will appear in the *Nakuru Weekly News* on 11th January, 1930, as the result of an

interview accorded by me. On the results of these experiments, I gave my opinion that farmers should consider growing wheat rather than maize at Njoro, and at least as much wheat as maize in the Nakuru and Rongai districts, as these districts appear to me to be better suited climatically to a quick-growing crop, than to a crop such as maize, which takes many months to mature.

Maize on the fertilised plots was a good stand, but for some reason of soil or rotation, at present unknown, it never grew vigorously, and the yield was obviously not as high as it should have been. Wheat had been the previous crop on the land.

Maize Planting and Spacing.

The factors with which the Plant Breeder is most concerned are those of the actual number of plants there are per acre and the individual spacing of those plants as well as the breeding of better seed. This question of individual spacing is, in the opinion of the Plant Breeder, the deciding factor in yields per acre in this Colony when other conditions such as soil, climate, cultivation and quality of seed are already in most cases averagely fair, and sufficiently good to allow greatly increased yields if more attention is paid to spacing of individual plants.

An experiment was made at the Njoro Plant Breeding Station in 1929 to determine the difference in yield given by an even stand of maize and a ragged stand. An even stand of maize is one in which every plant has an equal space of soil in which to grow and feed upon. A ragged stand is one in which plants are crowded together in some places and are too far apart in others.

Two one-thirds of an acre side by side were planted with an ordinary planter (ox-drawn) at the Plant Breeding Station. After a certain stage of growth both areas were thinned out. One was thinned out to an almost perfectly even stand (a perfectly even stand was not possible owing to minor inaccuracies in planting); the other area was thinned out to a ragged stand. Unfortunately, owing to comparatively good planting, it could not be left nearly as ragged as it should have been. That is to say, it was possible to leave gaps, but plants could not be crowded together as much as is normal. Some of them were, however, more crowded than in the even stand. The ragged stand, whilst definitely more ragged than the even stand, was a stand which few farmers would be dissatisfied with on their own farms.

Nevertheless, the even stand gave a yield of thirteen bags to the acre and the ragged stand a yield of only nine bags to the acre. Both yields are low, because that part of Njoro is too cold for maize and the rainfall was very inadequate. The yield of the even stand, however, was 44 per cent higher than that of the ragged stand. To explain it more plainly still, if a similar ragged stand in a maize belt gave twelve bags to the acre, an even stand would give seventeen bags to the acre which, with maize at Sh. 8 a bag on the farm, means a gross return of Sh. 136 per acre as opposed to Sh. 96 per acre. With maize at present prices (viz. Sh. 5/50 on the farm) the one means a gross return of Sh. 93/50 per acre, and the other of Sh. 65. The former shows a good profit; the latter hardly more than pays expenses. In this connexion it should be understood that what is normally called a ragged stand would probably not have yielded more than six or seven bags to the acre in the above experiment. Thinning out was so arranged in this experiment that exactly the same number of plants was left in each one-third of an acre, i.e. just over 9,000 to the acre.

The experiment to discover the difference in yield between an even and ragged stand was not of course an accurate one. This would have involved a large latin square, which it was not possible to undertake. The experiment was sufficiently accurate, however, to show what a great difference in yield there is between an even and a ragged stand.

Crop trials were also made with sunflowers, buckwheat, field peas, njahi and cowpeas. All but cowpeas did well. Considering their value as green manures, sunflowers yielded a much greater weight of green matter per acre than did buckwheat. Both field peas and njahi appeared very suitable for use as green manures in this district. There was, however, only fair nodular development but both crops set seed well.

G. J. L. BURTON,
Plant Breeder.

APPENDIX I.

ANNUAL REPORT OF THE SENIOR COFFEE
OFFICER, 1929.

STAFF.

Mr. C. B. C. Handley assisted me until July 13th, when he took over the duties of the Senior Agricultural Officer. During this period of six and a half months, most of his time was taken up with the *Stephanoderes* campaign and routine work. He also carried out inspections in Limuru, Kiambu, and Nyeri, in connexion with instructions issued under the Diseases of Plants Prevention (Coffee) Rules, and supervising the work of temporary inspectors in the vicinity of Nairobi, covering 1,106 miles. He held 122 interviews at Head Office during my absence and examined and passed coffee in parchment for seed purposes.

Three temporary inspectors and thirteen temporary assistant inspectors were engaged in January for the *Stephanoderes* campaign. After a course of instruction they were posted to the following districts:—

Inspectors in charge of—

Kikuyu-Ukamba : Mr. H. Naismith Jones.

Nyanza : Mr. R. Finch.

Uasin Gishu-Trans Nzoia : Mr. M. Godley.

Assistant Inspectors operating in—

Nyeri, Nanyuki : Mr. H. E. Fitzgerald.

Ithanga, Makuyu, Donyo Sabuk : Mr. T. H. G. Somerville.

Thika : Mr. W. D. Cass.

Ruiru : Mr. T. L. McClelland.

Kiambu : Mr. P. B. Robson.

Limuru, Upper Kiambu : Mr. H. Borman.

Nairobi, Ngong, Kabete : Mr. H. L. Bolton.

Rongai, Nakuru, Subukia, Solai : Mr. P. S. Bennett.

Koru, Kaimosi : Mr. G. H. Roberts.

Sotik, Fort Ternan, Lumbwa, and Kericho : Major R. N. Dunbar.

Elgon : Mr. R. G. W. Hudson.

Soy, Hoey's Bridge, Cherangani : Lt.-Commander F. B. Carslake.

Kipkarren, Turbo : Mr. M. T. Shelly.

At the end of February the temporary staff consisted of three Temporary Inspectors and eleven Temporary Assistant Inspectors, Messrs. Borman and Bennett having been permitted to resign.

At the end of March there were two Temporary Inspectors and nine Temporary Assistant Inspectors, Mr. Finch having been transferred to the staff of the Department as Assistant Agricultural Officer and Messrs. Carslake and Somerville having been permitted to resign.

The appointments of Messrs. Cass, Dunbar, Fitzgerald, Hudson, Roberts, Robson and Shelly terminated during the month of April. The services of Messrs. Naismith Jones, Godley, McClelland and Bolton were retained to form the nucleus field staff for future inspections.

Mr. Bolton was seconded to the staff of the Agricultural Department as Assistant Agricultural Officer in April, for four months, and was re-engaged on the 26th August as a Temporary Inspector. At the end of July, Mr. McClelland was transferred to the Entomological Section as Insectaries Manager. Mr. H. R. H. Stone was engaged on the 6th August as a Temporary Inspector to fill the vacancy caused by Mr. McClelland's transfer to the Entomological Section.

For the remainder of the year the temporary staff was employed in the following areas :—

Kikuyu Province : Mr. H. Naismith Jones.

Uasin Gishu, Trans Nzoia, Kaimosi : Mr. M. Godley.

Nairobi, Limuru and Kiambu : Mr. H. L. Bolton
(who also assisted me in the routine work at Head Office).

Nyanza Province : Mr. H. R. H. Stone.

Appointment of Temporary Honorary Inspectors.

In December, Messrs. M. D. Le Poer Trench, R. M. Dunbar, and R. Pearse, of Nyeri, Sotik, and Koru respectively, were gazetted Honorary Inspectors for the purpose of the Diseases of Plants Prevention (Coffee) Rules and Diseases of Plants Prevention (Coffee) (Amendment) Rules. The duties of these Honorary Inspectors will be to examine coffee seed for use in the Colony and issue certificates as to its freedom from insect damage. The delay caused in consigning coffee seed from certain districts, owing to an inspector not being available, has now been overcome.

TRAVELLING.

I travelled 6,072 miles in my car and approximately 500 miles in other cars, making a total of 6,572 miles travelled on Government duty.

INTERVIEWS.

I held 402 interviews in my office.

PUBLICATIONS.

Bulletin No. 9 of 1929, " Report on the Campaign against *Stephanoderes*, 1929," jointly with the report of the Senior Entomologist.

DISEASES OF PLANTS PREVENTION (COFFEE) RULES, 1928.

Certain irregularities and points in the Rules quoted above became evident during the campaign against *Stephanoderes* and *Sophronica*, and they were brought up for revision, and amended Rules came into force on April 22nd, 1929.

CORRESPONDENCE.

Inward letters numbered 1,476; outward letters numbered 1,022.

The following are some of the more important subjects which were dealt with :—

Pests and diseases; movement of coffee plants and coffee seed; licensed warehouses; manurial trials in connexion with mealy-bug; berry fall; *Stephanoderes* campaign; Kresotow; neglected coffee (72 notices under the Diseases of Plants Prevention Rules were served on occupiers); and other topics of an advisory nature.

Sixteen circulars were sent out in connexion with the following subjects :—

1. *Stephanoderes* and *Sophronica*, explaining the principles of the grouping required for stripping, etc.
2. Leaf-eating caterpillars and antestia in connexion with control measures as recommended by the Entomological Section.
3. Mealy-bug and Kresotow.
4. Terracing.
5. Irrigation.
6. Licensed warehouses.
7. Movement of coffee.
8. Instructions to inspectors.

A memorandum on the Introduction of New Varieties of Coffee, Plant Breeding and Vegetative Propagation prepared by Mr. Handley and myself was submitted.

The following topics were brought to the notice of the Department by the Committee of the Coffee Planters' Union and dealt with during the year.

1. The supply of Kresotow.
2. Mealy-bug.
3. Coffee fermentation.
4. Thrips.
5. Coffee adulteration.
6. Standard coffee bags.

Registration of Coffee Estate Marks.

A sub-committee of the Coffee Planters' Union agreed to submit a report on the salient points, with regard to the registration of coffee estate marks, for further consideration, and which should be embodied in a special Ordinance. This report has not yet been received.

COFFEE CONSULTING COMMITTEE.

No meetings were held this year; matters of any importance, however, have been referred to each individual member for his views. It is proposed to convene a meeting as soon as the proposals for forming a Coffee Board are received from the Committee dealing with this matter.

PROSECUTIONS.

Summonses were served on two Europeans under the Diseases of Plants Prevention Ordinance for failing to carry out instructions issued under the Diseases of Plants Prevention (Coffee) Rules.

In the first case the accused pleaded not guilty, but was convicted and fined Sh. 200.

In the second case the accused pleaded not guilty, but was convicted and fined Sh. 300.

COFFEE THEFTS.

Numerous cases of coffee thefts have been reported from different districts.

In Kiambu, a number of cases were brought before the magistrate by the police, and convictions were made.

MEETINGS.

I attended the following meetings :—

1. The annual general meeting of the Coffee Planters' Union.
2. The deputation of coffee planters which waited on you to request Government to make adequate provision for extra coffee services.
3. The meeting of coffee planters held under the auspices of the Coffee Planters' Union to discuss the formation of a Coffee Institute to control the industry. A committee was formed to inquire into the most suitable scheme.
4. Ruiru Farmers' Association dealing with the Kresotow position.
5. The deputation of coffee planters from Sotik and Kericho districts in connexion with coffee berry disease.
6. Sotik Farmers' Association.
7. Kericho Farmers' Association.

I accompanied the Mycologist to the Sotik and Kericho meetings, which were held in connexion with coffee berry disease.

I held seven meetings :—

1. In the library of the Department of Agriculture, attended by coffee merchants to discuss the movement and storage of coffee as affected by the new Coffee Rules.
2. In the Trans Nzoia.
3. In the Uasin Gishu.
4. On the Nandi Escarpment.
5. At Kaimosi.
6. At Solai.
7. At Songhor.

The object of these meetings was to explain the application of the new Coffee Regulations.

STATISTICAL INFORMATION.

The total area of coffee planted as at 31st July, 1929, is given as 90,205 acres. This figure shows an increase of 6,132 acres over the previous year.

There are 871 coffee planters who have submitted census returns; this represents 42.8 per cent of the total number of occupiers in the Colony.

It will be seen from the following comparative prices of Kenya coffee that the value decreased towards the end of the year. It may be attributed to two factors—

- (a) The quality of Kenya coffee was somewhat inferior, due to the drought in the early part of the year.
- (b) That there is a large quantity of low grade coffee on the world's market, and the price for inferior quality fell very low. Good quality Kenya, however, maintained a high price throughout the year.

It will be of interest to compare the London market prices for 1928 with those of 1929 :—

<i>Month.</i>		1928.		1929.
January	... ..	111/7	...	128/1
February	... ..	111/5	...	121/10
March	... ..	112/2	...	123/11
April	... ..	100/2	...	118/3
May	... ..	97/7	...	110/2
June	... ..	93/9	...	98/1
July	... ..	87/0	...	96/2
August	... ..	109/8	...	96/10
September	... ..	111/10	...	100/10
October	... ..	113/4	...	88/2
November	... ..	115/8	...	92/11
December	... ..	118/11	...	106/3

The following average prices for the last three crops are given for comparative purposes :—

1926-27	...	July-June	...	118/70
1927-28	...	July-June	...	103/30
1928-29	...	July-June	...	113/20

In comparing these figures with the previous statement, it should be noted that the prices in the early part of 1929 were considerably higher than those prevailing during the same period of the previous year, but fell away in the latter half of the year 1929.

EXPORTS.

During the year ended 31st July, 1929, 145,880 cwt. of coffee were exported from the Colony, valued at £785,171.

This figure represents 31.1 per cent of the value of the total agricultural exports of the Colony.

MOVEMENT OF COFFEE.

The response on the part of certain planters and traders to the Rules governing the movement of coffee has not been as satisfactory as it might have been. There has been deliberate obstruction on the part of some planters and traders. It is realised that there will be a certain amount of inconvenience to the planter and trader, but it should be appreciated that the Rules governing the movement of coffee have been brought into force for a good purpose.

MOVEMENT OF COFFEE PLANTS.

The Solai and Subukia District Associations have passed resolutions at their meetings that they wished to be placed in a closed area with regard to the importation of coffee plants and coffee seeds, with a view to maintaining the coffee in these districts free from pests and diseases. The risk of introducing insect pests through the importation of coffee seed does not arise, as no coffee for seed purposes may be disposed of unless such seed has been inspected and certified as free from pests and diseases by an inspector authorised in that behalf. Two other applications have been received from the Kipkarren Farmers' Association and Mount Kenya Association for the prohibition of the movement of plants of all description from districts infected with mealy-bug.

A circular letter on this subject has been addressed to all members of the Coffee Consulting Committee for an expression of their opinion. Under the present regulations the Administrative Districts of Nairobi, Kiambu, Fort Hall and Donyo Sabuk are in quarantine, and no plants from any of these districts may be moved to any part of the Colony.

Under a permit coffee plants from the Limuru area may be moved to any district in the Colony.

COFFEE SEED.

During the year some 4,970 lb. of coffee for seed purposes was inspected and passed by different members of the staff. The examination of this coffee revealed a very low standard for seed purposes.

In many cases little or no attempt has been made in seed selection.

There has been an increased demand for Mysore coffee to be grown in cold situations, and it is unfortunate that good seed has not always been used. It is obvious that if conditions are not very favourable for coffee it is of the greatest importance that the very best seed should be planted. For this reason it is felt that the propagation of Mysore coffee, when grown under adverse conditions, may give disappointing results.

To avoid any inference that coffee for seed purposes has been examined for quality as seed, instructions were issued to all inspectors to the effect that the description "coffee in parchment" and not "coffee seed" was to be used when issuing a certificate of cleanliness.

A one-pound sample of coffee seed, "Harar" variety, was received from the British Consul, Abyssinia, for trial at the Scott Agricultural Laboratories; other varieties of coffee seed are expected shortly for trial in the Colony, the names of which will be given when they arrive.

Fifty coffee bushes have been selected over an area of fifty acres of Mysore coffee on Dr. Kauntze's plantation in Limuru district (altitude, 6,700 feet). It is proposed to keep these trees under observation and select seed from them next year, 1930-31 crop, for distribution at high altitudes on Elgon and Tinderet.

SHADE.

Some thousands of cuttings of *Gliricidia maculata*, and about one hundred cuttings of *Mukungugu* were distributed to coffee planters in Songhor, Kipkarren, Turbo, Trans Nzoia, Kaimosi, Sotik, and Nandi. Fifty one-ounce packets of *Gliricidia maculata* seed, imported from Ceylon, were also distributed.

MANURING.

Green Manures.

Small samples of the following crops were distributed for trial in different districts :—

Mauritius Bean, Field Peas, Cowpeas, Njahi, Niger Oil, Hairy Vetch, *Crotolaria incana*, and Scarlet Runner.

The cover crops in order of merit grown on the slopes of Elgon are :—

1. *Field Peas and Njahi*.—Both did extraordinarily well, and can be recommended for that area.

2. *Cowpeas*.—The germination was very poor, but the few plants which grew indicated that it would be probably a good green manure for coffee if the germination was satisfactory.

3. *Hairy Vetch*.—Made very slow growth, but eventually covered the ground satisfactorily. It would be more suitable as a cover crop than a green manure.

4. *Crotalaria incana* and *Scarlet Runner*.—Unsatisfactory.

I have not had the opportunity of examining these crops in other districts where they were sent for trial.

PRUNING.

There is room for considerable improvement in regard to pruning.

A great deal of harm is often done to the coffee bushes by mishandling. Knives are freely used with the result that much wood which should not be cut at the time of "handling" and "centring" is cut away. The result of such treatment is often detrimental to the bushes. Pruning is very often delayed owing to the long-drawn-out harvesting of the crop. Some planters place far too much importance on endeavouring to harvest the very last ripe cherry. There is a stage when the picking becomes uneconomical, and the remaining crop should be stripped so that the labour could be used for pruning and other matters of importance, such as combating possible serious outbreaks of insect pests or fungoid diseases. Control measures against pests or diseases are usually more effective if the bushes are pruned before the treatment is carried out.

If there were more co-operation amongst coffee planters, successful meetings might be held quarterly on different *shambas* for exchange of opinion. Such meetings would be educational as each planter would have the opportunity of discussing his problems in the presence of experienced and successful planters.

The Kipkarren Association have adopted this course with success.

Multiple Stemmed Trees.

The last few years have not been good seasons, owing to shortage of rain, for establishing multiple stemmed trees. This factor, alone, however, is not responsible for the failure of the system; it has been due to the system not being correctly

carried out. In cold districts and where there is a good rainfall the system has given better results than in the drier districts, not that pruning methods have been correctly carried out, but merely because there has been more rainfall to make up for the excessive wood left on the trees. In many instances no pruning has been done; trees standing nine feet high have had no primaries cut away, nor has there been any "handling" and "centring" carried out, giving three to six bearing stems, together with numerous young suckers. Primaries have been left to bear two and three crops longer than they should; secondaries left to bear in like manner. The result is that the vertical stems become very rigid and break easily during the picking season, the beans are small in size and inferior in quality, and there is delay in establishing subsequent suckers.

INSPECTIONS.

I made 175 visits to coffee plantations in the undermentioned districts, and fifty-one visits to the Scott Agricultural Laboratories :—

Kiambu	...	...	...	...	40
Ruiru	...	...	...	...	23
Thika, Makuyu, Ithanga	...	...	...	...	16
Ngong	...	...	...	...	2
Limuru	...	...	...	...	2
Nairobi	...	...	...	...	1
Trans Nzoia	...	...	...	...	32
Uasin Gishu	...	...	...	...	9
Kaimosi	...	...	...	...	3
Nandi	...	...	...	...	6
Muhoroni, Songhor	...	...	...	...	14
Fort Ternan	...	...	...	...	4
Kericho, Buret, Sotik	...	...	...	...	9
Lumbwa	...	...	...	...	4
Solai	...	...	...	...	4
Rumuruti	...	...	...	...	1
Thomson's Falls	...	...	...	...	1
Coast	...	...	...	...	4
Total					175

The following Appendix shows a summary of the number of inspections carried out in connexion with the *Stephanoderes* campaign, also showing the distribution of insect pests and diseases up to the 31st May, 1929.

While *Stephanoderes* and *Sophronica* were the main object of the campaign, the opportunity was taken of making a general survey of all the diseases and pests occurring in coffee plantations.

A separate report on this campaign has been submitted to you.

In the course of inspections, forty-two totally abandoned or neglected *shambas* were discovered; on most of these instructions were carried out satisfactorily, but in a few cases it was necessary to bring a certain amount of pressure to bear before the menace was removed.

STEPHANODERES AND SOPHRONICA.

The confirmation of *Stephanoderes* and *Sophronica* was in the hands of the Senior Entomologist; no farm was considered to be infected until such confirmation was made.

There are three districts infected with *Stephanoderes*, namely Ruiru, Sotik and Kaimosi. *Sophronica* is fairly generally distributed in all districts, and it would appear that there is more damage being caused to coffee beans by the larvæ of the *Sophronica* beetle than by *Stephanoderes*. Broken beans, which are often mixed with the shell of elephant beans, have been found to be the result of *Sophronica* damage.

It is considered probable that one of the primary causes of the increase in numbers of these pests has been due to the method of harvesting the crop, allowing overripe berries to remain on the trees and on the ground, forming an ideal breeding-place for the beetles, which up to date have only been found breeding in *buni* coffee. There has been no record of *Stephanoderes* prior to 1928.

MEALY-BUG.

P. lilacinus.

Considerable loss of crop has resulted from the ravages of mealy-bug in Ruiru, Thika and parts of Kiambu.

Many planters who postponed banding early in the year, or who did not take the precaution to have a supply of Kresotow in stock, were the heaviest losers. Some planters advocated that banding need only be carried out by a certain month, and, in practice, carried this out, regardless of the infection of the bushes. Experience on the other hand has shown that there can be no hard and fast rule as to the time of year when this operation should be carried out, as it will depend on the time of the year when the infestation commences and the activities of the mealy-bug.

Reports show that mealy-bug is more widely distributed in Limuru and Makuyu than in previous years.

P. perniciosus.

Reported on two plantations in the Trans Nzoia; infestation on one plantation severe.

Icerya Nigroaureolata.

Found on one plantation in Sotik, and later in the year was reported on a farm in Ruiru. In both cases the outbreak was slight.

A series of manurial trials in connexion with mealy-bug infestation have been laid down on several plantations in Kiambu, Ruiru and Thika as a result of investigations carried out by Mr. Gracie, Assistant Agricultural Chemist, and myself, in soil conditions and the incidence of mealy-bug.

STEM BORERS.

Anthores, the White Borer.

Very severe outbreaks have occurred in the Ithanga area, and more particularly in the Ithanga Valley. Over sixty acres of affected coffee have been uprooted and burned. Steps have been taken to have frequent inspections made in this area, with the object of preventing its spread in the district.

Black and Yellow Borers.

These pests are on the increase; they are more widely distributed in the Kikuyu Province than in previous years. Infested trees are either treated with carbon-bisulphide or cut down and burned.

LEAF-EATING CATERPILLARS.

Severe outbreaks of leaf-eating caterpillars, *Metradrepana andersonii*, have occurred in Nyanza Province. This pest has occurred for several seasons in this Province, and no serious attempt was made to combat it until this year, when coffee planters were notified that it would be compulsory to spray with a mixture recommended by the Senior Entomologist. The response was most satisfactory, and it is hoped that all planters will continue to co-operate in the campaign against this pest.

ASTEROLECANIUM.

Asterolecanium, the Yellow Fringed Scale.

Reports show that this pest is more widely distributed in Thika—Makuyu than in previous years. Large areas of coffee in Thika have been stumped owing to the very severe infestation on the bushes.

Spraying with Volek, 1 in 25 parts, has been found effective in controlling this pest.

It has been reported for the first time on the slopes of Elgon.

ANTESTIA.

This coffee bug is widely distributed throughout the Colony.

In Nyanza Province, Antestia has caused considerable loss of crop.

Some planters claim great success from the frequent use of arsenite of soda poison bait mixture, while others are dissatisfied with the results.

THRIPS.

This pest was responsible for loss of crop in Ruiru, Thika, and more particularly in the Trans Nzoia. The most effective means of control are spraying with a lime sulphur mixture and cutting out windbreaks to allow a free passage of air through the plantation. The pest is immediately checked as soon as the rains commence.

COFFEE BERRY DISEASE.

Coffee berry disease has been very prevalent throughout Nyanza, Uasin Gishu and Trans Nzoia Provinces. Inspections show that this disease is on the increase. Heavy loss of crop has been reported from Sotik, Kericho, Kaimosi, Turbo and parts of the Trans Nzoia.

At a meeting held at the office of the Department of Agriculture in November, when a deputation of coffee planters from Sotik and Kericho waited on you to discuss the question of coffee berry disease, it was stated that spraying, at the present time, did not prove effective, and that many of the planters present had spent considerable sums of money on spraying, and had lost a large percentage of their crop. As a result of this meeting an examination of the possible causes of the comparative failure of spraying was made by the Mycologist and myself. With few exceptions, the reports on the loss of crop from coffee berry disease were exaggerated. A few farms have certainly suffered severely, and spraying has not been as effective as one had expected, but the failure cannot be attributed entirely to the non-effective results of the spray, as the methods employing in pruning and "handling" exercise a large bearing on the vitality of the bushes; further, excessive and useless wood will interfere with effective spraying.

I do not consider, however, that spraying should be relied upon entirely when dealing with such a virulent disease. More attention should be given to the improvement and maintenance of soil fertility. Attempts have been made to carry out co-operative experiments on two lines, namely seed selection from resistant trees and fertiliser experiments, but without exception, due to the lack of co-operation, they did not materialise.

Steps have been taken by the Mycologist to pursue soil investigations and manurial experimental plots will be laid down early in 1930.

A planter in Sotik claims considerable freedom from coffee berry disease owing to an application of half a ton of lime per acre over a period of four years.

Another planter, who has limed at the rate of eight cwt. per acre, in addition to spraying, claims to be very free from coffee berry disease in an area where other plantations have suffered heavy losses.

BROWN BLIGHT.

Much more damage has been caused by this disease than planters realise, as in many cases brown blight damage is mistaken for coffee berry disease. A few planters claim great benefit from spraying, and all are agreed that the collecting and burning of fallen coffee is of the utmost importance in connexion with controlling serious attacks of brown blight and coffee berry disease.

SCOTT AGRICULTURAL LABORATORIES.

The varieties established on the single and multiple stemmed system bore a heavy crop. Stripping had to be carried out much earlier than usual to check die-back.

During the dry season the coffee under tree and artificial shade remained a healthy green colour, as compared with the unshaded coffee, which had a yellowish tinge.

Gliricidia maculata has made good growth; the coffee bushes do not appear to suffer from competition with these shade trees during a dry spell.

Further selection work has been done with K.S. and E.S. types. These are the names to which the type selections, on which I am working, will be referred.

An irrigation experiment has been commenced on one of the varieties established on the multiple stemmed system.

The total yield of parchment for the year was 4,437 lb., and the strippings, *mbuni*, 1,238 lb.

With Mr. Leckie's assistance, budding and grafting of coffee was tried. An area of coffee has been planted out this year for the purpose of experimenting with vegetative propagation.

A small area of wild Nandi coffee, *Coffea eugenioides*, was planted out during the short rains. It is some distance from and on the leeward side of the other varieties.

During the year the Public Works Department erected a coffee factory on Plot No. 18; unfortunately, work was not finished until the end of the year, consequently great difficulty was experienced in handling the crop.

GENERAL.

A new system of recording inspections has been evolved in order that the spread of diseases or pests can be easily ascertained. This record, however, has not been kept up-to-date, as there is no one available to do the work.

The Agricultural Chemist's bacterial culture will be a boon to coffee planters, especially in cold areas, where coffee takes over two days to ferment.

The following statement shows the amount of Kresotow received in the Colony since 1927 in 5-gallon drums:—

1927	...	...	...	200 drums.
1928	...	...	...	800 „
1929	...	...	...	1,995 „

Coffee planters have been repeatedly requested to inform the Department of their requirements for Kresotow, as the Department can hardly be expected to anticipate every settler's requirements. The response to this request has been very poor; orders for Kresotow supplies have been 100 per cent in excess of orders placed by planters.

The Kresotow received in 1928 and a part of the supplies received in 1929 was not of good quality. One consignment, which proved detrimental by soaking through the grease-proof paper into the bark of the tree, satisfied the tests laid down in the specification both here and in England. Arrangements have been made with Messrs. Cooper, McDougal and Robertson, and their agents, Messrs. J. W. Milligan and Co., to continue the supply of Kresotow and to hold adequate stocks

to meet the requirements of the coffee industry, as Government has ceased to import any further supplies. Other substances which are being used in connexion with mealy-bug control are Bandite and T.C.N.6. Many planters express satisfaction with the results of these sticky substances, which are effective in keeping ants off the trees; they are certainly worthy of further investigation. The Department imported a consignment of Bandite Tanglefoot for experimental purposes.

There have been grossly exaggerated statements made regarding the loss of crop as a result of mealy-bug damage. There has been certainly a heavy loss of crop during the season 1929, but this loss has been mainly due to a combination of factors, namely shortage of rain at the end of 1928 and the commencement of 1929, also the ravages of mealy-bug and thrips; the lack of rain was the predominating factor. The loss of crop from mealy-bug has been very severe, but the inaccurate statements made show the loss to be far greater than actually occurred. Statements of this inaccurate and grossly exaggerated nature are very harmful and retard the progress of the industry; in other words, prospective settlers would be alarmed at the figures said to be caused by the ravages of mealy-bug.

The crop prospects for the forthcoming year appear to be excellent; the rains have been general throughout the Colony up to the end of the year.

ARTHUR TRENCH,

Senior Coffee Officer.

APPENDIX J.**ANNUAL REPORT OF THE LIVE STOCK
OFFICER, 1929.**

I arrived in the Colony on first appointment on the 7th March, 1929.

An early opportunity was taken to make a preliminary tour of inspection to observe the different types of farming, local conditions, and to establish contact with the farmers.

CORRESPONDENCE.

Outward letters numbered 297, of which 105 were advisory letters, dealing with specific inquiries with reference to the feeding of cattle and pigs, the preparation of dairy products, and general stock management.

INTERVIEWS.

Twenty-five interviews were held at my office.

TRAVELLING.

During the period under review, 6,179 miles were travelled on Government duty, and I have been away from Head Office on 159 days.

FARMS VISITED.

Total 223, in the following areas :—

Nairobi, Limuru, Naivasha, Gilgil, Nakuru, Molo, Londiani, Lumbwa, Solai, Thomson's Falls, Rumuruti, Ngobit, Nyeri, Nanyuki, Mau, Kiu, Kimaa, Subukia.

LECTURES.

Four, on stock management, were given at Nanyuki, Subukia, Naivasha and Londiani.

NATURE OF WORK ON FARMS.

Although during this period visits to farms were paid with the main object of observing the different types of farming, studying local conditions and establishing contact with the farmers, advantage was taken of my presence on the farm to discuss not only past achievements and present methods, but the extent of future economic development.

It might be said that a newcomer to the country could be of little help; but the facts that the number of requests for return visits is so great that it is found impossible to comply

with them within reasonable time, and that the number of advisory letters sent, indicate that the suggestions made have been appreciated and further assistance is desired.

A wide range of subjects has been dealt with, embracing the breeding and selection of stock and their general management, the adaption of the farm layout for better methods of management, the trial and use of suitable fodder crops, and the improvement of pastures.

The breeding, management and feeding of pigs has received special attention with a view to improving the quality of pigs sent forward to bacon factories.

The selection of future breeding stock and more economical feeding to assist earlier maturity are the main points receiving attention.

In all these matters past experience and knowledge has been applied to local conditions. Some of the points appear elementary, but guidance in the fundamentals is essential in a young colony which has little accumulated data to work upon.

It is a pleasure to be able to record the willingness of farmers to adopt suggestions, and their appreciation of what help it has been possible to give.

DAIRYING.

The development of the dairying industry has been one of my main aims. This entails encouragement of the co-operative ideal in the disposal of produce, assistance and advice as to the proper care of, and attention to, cream for butter-making, and the proper management of milk for disposal as whole milk.

In some cases practical help and instruction in butter and cheese making have been given, with the acknowledged permanent improvement in the farm product.

If the expansion in farm cheese-making noticed during the past year is maintained, it will be necessary for Kenya cheese-makers to change the type of cheese to a long-keeping cheese instead of the short-keeping variety at present produced. This would greatly facilitate the placing of cheese on the export market should that necessity arise.

The increased production of cream during 1929 is to be noted and will, I hope, be maintained, but creamery suppliers should realise that for the production of first-class export butter

it is essential to supply cream of a high quality, fresh and free from taint. However efficient the factory management, the finished product—butter—depends on the quality of the raw material—cream.

A good deal of advisory work on the farm will be necessary before this position can be considered satisfactory; conditions vary greatly, and no universal method can be applied.

In conjunction with the Secretary of the Royal Agricultural and Horticultural Society of Kenya and the Medical Department, an initial effort was made at the Nakuru Agricultural Show, held in December, to bring the dairy industry and attendant improvements thereof more prominently before the public eye.

PIG INDUSTRY.

In April a conference on the pig industry was held at the offices of the Department, as a result of which a Pig Industry Consulting Committee was appointed, which met in July. Work in connexion with the above occupied a considerable amount of my time.

Resolutions of particular interest passed at these meetings included :—

“ That it is in the interests of the pig industry that bacon curers should graduate their prices according to the quality of pigs received.”

“ And recommends that bacon curers and pork butchers should not buy pigs of very inferior quality.”

A resolution asking for a revision of the railway freight rates in pig foods.

The pig conference desired that it be placed on record its opinion that both educational propaganda and satisfactory prices for pigs of good quality were factors in the improvement of the breeding of the pig, and notes with satisfaction that the Department of Agriculture is now able, through the Livestock Officer, to give advice in this regard.

As a result of these meetings, a reduction in bacon prices was made by the leading manufacturers. Local consumption immediately rose, and that rise has been maintained.

A point of importance is the fact that bacon prices have now reached a lower level than has ever been experienced before in the history of the Colony.

Following on representations made by the Department of Agriculture, substantial reductions in the freight rate for pigs' foods have been sanctioned by the Railway Administration.

GENERAL.

Administrative work in connexion with the stock industry occupied my attention at Headquarters for approximately 50 per cent of my time.

Under the schemes for assisted importation of pedigree livestock, 17 bulls and 22 heifers, 22 sheep and 4 pigs were imported in 1929.

All inquiries other than veterinary relating to horses, cattle, sheep, pigs, and dairy products have been dealt with (192 letters), and apart from special advisory work (105 letters) several extensive memoranda in connexion with the cattle, sheep and dairy industries have been compiled for the assistance of the Director.

An article on cattle for Kenya for the International Pedigree Stock Breeders' Register, which has a distinct publicity value to the Colony, and a pamphlet on sheep for publication through the Kenya Advisory Committee, have been prepared.

W. D. D. JARDINE,

Livestock Officer.

APPENDIX K.

ANNUAL REPORT OF THE ACTING CHIEF GRADER
AND INSPECTOR FOR THE YEAR ENDING
31st DECEMBER, 1929.

STAFF.

The following changes occurred during the year :—

Mr. F. B. L. Butler proceeded on leave on the 13th April and returned on November 22nd.

Mr. J. Clark, Temporary Assistant Grader, left the Department on June 30th, on the termination of his appointment.

Mr. A. D. T. Montagu, Assistant Grader and Inspector, arrived on first appointment on November 2nd.

Zahid Hussein, Asiatic Mechanic, proceeded on leave on the 7th August, and returned on the 21st November.

PLANT IMPORT INSPECTION.

The following table shows the quantities and values of the various importations of plants and seeds :—

	No. of packages	Declared value	
		Sh.	cts.
Seeds	1,216	64,831	34
Fruit	11,235	128,452	72
Plants	222	8,564	37
Fruit Trees ..	406	32,783	28
Tea Seed	3,037	441,703	79
Tree Seed ..	17	360	50
Bulk	162	5,128	12
	16,295	Sh. 681,824	12

The figure of 16,295 packages is an increase of 3,212 packages over the previous year's figures, showing an increase in value of Sh. 66,848/96.

In addition, seventy-four packages, value Sh. 1,494/30, were passed in transit to Uganda.

A new fumigating shed was taken over by the Department from the Kenya and Uganda Railways and Harbours on December 28th.

GRADING AND CONDITIONING SERVICES.

Maize Grading.

The table in Appendix I is a monthly statement of maize graded. The total of 450,420 bags is a decrease of 3.3 per cent as compared with the previous year's total of 465,853.

The slight decrease of the crop available for export was due to two main causes—

- (a) Restriction of export by the Food Control Board ;
- (b) Late commencement of the export of maize from the 1929 crop.

During the first three months of the year there was a marked increase in the percentage of wet maize received ; 14.7 per cent of the maize graded was rejected as wet. Similar periods for 1927 and 1928 showed 7.7 per cent and 6.2 per cent respectively. There was, however, a noticeable reduction in the percentage moisture content of the wet maize as compared with the previous year.

No native maize was presented for grading.

The following table shows the principal quantities of wet maize received from the different districts, together with the average moisture content.

Sending Station	Number of bags	Average Moisture content
		Per cent.
Kitale	18,585	13.77
Hoey's Bridge ..	5,680	13.90
Turbo	533	14.20
Eldoret	1,715	14.45
Soy	5,397	13.75
Lugari	3,535	13.7
Chemelil	280	13.5
Nakuru	709	13.7
Wet by rain ..	782	..

Stations forwarding less than 200 bags of wet maize are not included.

Shipments.

One hundred and seventeen export certificates were issued for a total of 373,698 bags, comprised as follows :—

97 certificates for 216,988 bags K2.

14 " " 154,449 " K2, shipped in bulk.

4 " " 1,134 " K3.

2 " " 1,127 " K6.

A very large number of second-hand bags was used when maize was shipped in bulk. Advantage was taken of bulk shipments to allow consignments of maize slightly under prescribed weight laid down, viz. 202 lb. per bag, to be shipped without adjustment, thus avoiding congestion during the busy season.

Rule 25.

As allowed under this rule, 31,064 bags of maize were exported without certificate; this is a decrease of 71 per cent as compared with the total for the previous year of 107,352 bags.

Early in the year this consisted of native maize, together with small quantities of Grade 3 and rejected maize. During April and May, however, practically the whole of the maize shipped would, if graded, have been second grade (K2). There was during this period a brisk local trade for all classes of maize.

Wheat Grading.

Appendix II. Tables (a), (b), (c), (d), and (e) give the quantities graded in each month, variety, and their grades, and the quantities graded at the Conditioning Plant. Table (f) shows totals of varieties graded and their grades.

It will be seen that 35,302 bags were actually received from up-country, and presented for grading, but owing to re-grading after passing through the Conditioning Plant, a total of 53,145 bags was graded.

The total of 35,302 bags was comprised as follows :—

Equator 26,250 being 74.35 per cent. of total received

Kenya Governor 5,347 " 15.14 " "

Durum 3,705 " 10.5 " "

Other varieties : Nil.

Attention is here drawn to very high figures shown under "rejected as wet," the total of 15,896 bags being 45 per cent of the total received. The three varieties graded show the following figures:—

Equator 12,517 bags being 47.6 per cent. of total received.

Kenya Governor .. 1,869 " " 35 " "

Durum 1,510 " " 40.7 " "

It is difficult to state a definite cause for this very high percentage of wet wheat; methods of harvesting, stacking and storing are obviously to blame to a great extent.

The following table shows the principal stations from which wet wheat was received, together with the average moisture content:—

WET WHEAT, 1929.

Station of origin	No. of bags	Moisture content
		Per cent.
Molo	1,727	14.6
Plateau	517	15.2
Maji Mazuri ..	1,813	14.2
Mau Summit ..	1,723	14.3
Eldoret	1,480	15
Narro Moru ..	1,020	14.8
Kitale	276	14.8
Elburgon	493	15
Lumbwa	340	15.9
Ainabkoi	938	14.3
Londiani	140	15.1
Gilgil	110	13.3
Q. N. D.	200	13.8
Turbo	172	14
Kipkabus	904	14.2
Kibos	120	..
Eburru	250	14.2
Nakuru	266	14.6

Stations having less than 100 bags of wet wheat are not included.

Shipments.

Seventy export certificates were issued for 34,158 bags of wheat. The following table gives particulars of varieties for which the certificates were issued :—

Grade	Equator	Governor	Durum	Other Varieties
First Grade ..	21,366	4,097	1,981	..
Second Grade	5,601	694	405	..
Third Grade ..	..	6	..	..
First Grade (SW)	..	8	..	..

Wheat was exported to South Africa, India, Europe, and to ports on the East Coast of Africa.

General.

During January, wheat of good colour, plump grain, and having a high bushel weight, viz. up to 66 lb. per bushel, was graded. During March, April, May, there was an appreciable falling off in the quality of the wheat graded, a bushel weight of 61 lb. being seldom exceeded. Much of this wheat was of poor colour, lacking transparency and strength. Very wet wheat which has lost its colour is greatly improved by drying, although it is impossible to remove completely the dark colour caused by excessive wetness and prolonged sweating. Much of this wheat, whilst having a poor colour, has the requisite bushel weight for First Grade.

Evidence of black stem rust (*Puccinia graminis*) was found in some consignments of wheat, and was responsible for much undeveloped and shrivelled grain.

MAIZE AND WHEAT CONDITIONING PLANT.

Maize.

49,239 bags of maize were treated at the Conditioning Plant, being an approximate increase of 5.5 per cent over the previous year's total of 46,656. No maize was treated for the destruction of weevil.

Wheat.

18,429 bags of wet wheat were treated at the Conditioning Plant, being a decrease of approximately 13 per cent on last year's figure of 21,155 bags.

General.

Of the total of 67,668 bags of maize and wheat conditioned, 66,037 bags were treated during the first four months of the year.

No consignments of wet maize and wheat were consigned direct to the Conditioning Plant, possibly owing to a certain amount of congestion during the busy season.

The New Year opened with the Plant working twenty-four hour shifts, which had commenced on the 13th December, 1928, and continued until February 15th. Thirty-nine days were worked at this rate, with six day and night and fourteen day and night non-stop runs.

Normal shifts were resumed on February 16th, the plant working more or less regularly until May 21st, during which period shifts varying from four to eighteen hours were worked.

Early in the morning of January 1st a breakdown occurred owing to a fracture of one of the main shafts. The Plant resumed work at 5.30 p.m. on January 7th.

The peak period of congestion was reached on January 8th, when 14,759 bags of wet maize and 3,345 bags of wet wheat were on hand.

Apart from this breakdown, the plant worked satisfactorily throughout the year.

The annual overhaul was carried out during June, July and August.

To obviate as far as possible stoppages due to boiler trouble, a new Cradley vertical boiler was installed during the year. The erection of the new boiler in the existing boiler house necessitated the extension of the existing boiler room. This work was commenced on July 4th. The erection, fitting up, and connecting to steam circuit was completed on Friday, August 30th. Final tests carried out were considered very satisfactory.

Grading of Potatoes.

The following table shows the months and the quantity in cwt. of potatoes graded, together with the grades :—

GRADE IN CWTs.

Month	1	2	Seed	R. J.	Totals
January ..	152	2,836	..	119	3,107
February ..	833	470	..	..	1,303
March ..	..	2,074	..	90	2,164
April ..	..	1,931	..	..	1,931
May ..	..	1,424	..	..	1,424
June ..	..	2,222	..	347	2,569
July ..	..	2,461	..	268	2,729
August ..	..	4,789	..	339	5,128
September ..	..	11,307	..	216	11,523
October ..	829	16,057	..	298	17,184
November ..	..	11,718	..	..	11,718
December ..	..	6,712	11	..	6,723
	1,814	64,001	11	1,677	67,503

The figure of 67,503 cwt. is an approximate increase of 51.9 per cent over the total graded for the previous year.

More than 88 per cent of the potatoes graded were consigned to Bombay.

Whilst hand-picking was frequently necessary, the potatoes presented for grading were of a very uniform quality.

The principal defect in the potatoes submitted for grading is the high proportion of tubers mechanically injured in the process of lifting the crop. During July and August consignments of unripe potatoes were submitted for grading and were rejected.

Inspection of Beans.

Forty-seven certificates for 4,323 bags were issued, being a decrease of 14.8 per cent as compared with the total of 5,074 bags for the previous year.

COOL STORES.

Except for three short stoppages, caused by power failures due to the fluctuation of current, the machinery has worked satisfactorily. The stoppages noted did not affect the efficient working of the plant, although fluctuations in the power current have necessitated very careful watch being kept by the mechanic in charge.

New duplicate plant arrived in August, and the erection and other necessary alterations were completed in December.

The work of assembling the machinery, cutting, screwing and fitting of pipes, etc., was carried out by the mechanical staff of this Department; alterations to permanent structures and the roofing over of condensers were done by the Public Works Department; the fitting of necessary electrical appliances and connecting wires, etc., was carried out by the East African Power and Lighting Co.

The original plant needs overhauling, and this work will commence at an early date.

The following quantities of goods were received into Cool Stores during each month of the year, *vide* Appendix III.

The following table shows increases and decreases of the quantities of commodities deposited during 1929, as compared with the previous year's figures :—

Commodity	Increase	Per cent Increase	Decrease	Per cent. Decrease
Fruit	26,781 lb.	20.8 %	..	..
Fresh Fish ..	17,661 "	124 "	..	..
Cured Fish ..	14,760 "	29.4 "	..	..
Cheese.. ...	3,088 "	325.4 "	..	..
Offal	4,734 "	597.4 "	..	..
Poultry ..	..	..	77.33 doz.	61.29%
Butter	..	..	179 c/s	7.2 "
Beef	89 qrs.	42. "	..	..
Mutton & Pork	69 carcasses	48.2 "	..	..
Eggs	161 doz.	147.7 "	..	..
Ham & Bacon	426 lb.	160.1 "	..	..
Vegetables ..	..	..	4,459 lb.	54.6 "

It will be seen that the increase in deposits during the year was very considerable, and can be considered very satisfactory.

VISITORS.

Many visits have been made by persons passing through Mombasa.

The Governor General of Madagascar visited the Department in February; arising out of this visit, Monsieur C. Barriety, Docteur en Droit, Administrateur des Colonies, together with other heads of departments, were received on June 27th. The grading and conditioning and inspection services were fully explained and discussed. Considerable surprise was expressed by these gentlemen at the thorough manner in which these services were carried out.

C. S. SILVESTER,

Acting Chief Grader and Inspector.

APPENDIX I.—MAIZE MONTHLY STATEMENT: JANUARY 1ST TO DECEMBER 31ST, 1929.

Month	K2	K2SW	K3	K3SW	K4	K6	K7	K8W	Total Graded	Wet	Musty	Weevily	Other causes	Total rejected	Total received	Rebaggged	Resewn
January ..	104,103	1,112	680	..	..	27	..	11	105,933	30,042	1,287	58	3,574	34,961	140,894	50	86
February..	154,178	1,222	2,090	11	..	..	30	4	157,535	10,966	135	25	10,424	21,550	179,085	224	4
March ..	82,219	2,015	1,647	..	3	1,129	..	7	87,020	559	18	388	7,942	8,907	95,927	126	60
April ..	33,304	861	15	..	..	..	..	16	34,196	7	..	..	1	8	34,204	47	4
May ..	310	..	..	..	..	..	..	..	310	..	..	..	..	..	310	..	..
Total..	374,114	5,210	4,432	11	3	1,156	30	38	384,994	41,574	1,440	471	21,941	65,426	450,420	467	374

No returns for the seven months from June to December inclusive.

APPENDIX II (a).—WHEAT (EQUATOR) MONTHLY SUMMARY—JANUARY 1ST TO DECEMBER 31ST, 1929.

Month	Grades			Total Graded	Rejected			Total Rejected	Total Received
	K1	K2	K3		Wet	Musty	Other Causes		
January ..	317	4	..	321	1,006	35	14	1,055	1,376
February ..	2,399	931	588	3,918	1,505	96	485	2,086	6,004
March ..	2,999	1,177	431	4,607	6,101	126	77	6,304	10,911
April ..	1,529	359	..	1,888	2,685	34	1	2,720	4,608
May	..	780	..	780	1,220	..	..	1,220	2,000
November ..	1,351	..	..	1,351	..	..	..	..	1,351
Totals ..	8,595	3,251	1,019	12,865	12,517	291	527	13,385	26,250

There were no Returns for the following months: June, July, August, September, October, December.

APPENDIX II (b).—MONTHLY STATEMENT, WHEAT (GOVERNOR): JANUARY 1ST TO DECEMBER 31ST, 1929.

Month	Grades				Total Graded	Rejected			Total Rejected	Total Received
	K1	K2	K3	K1-S.W.		Wet	Musty	Other causes		
January..	370	195	64	..	629	..	1	24	25	654
February	..	260	413	..	673	380	41	82	503	1,176
March ..	544	..	..	..	544	695	19	161	875	1,419
April ..	368	129	6	6	509	383	3	111	497	1,006
May ..	109	473	95	..	677	276	..	4	280	957
December	..	..	..	..	..	135	..	..	135	135
Total ..	1,391	1,057	578	6	3,032	1,869	64	382	2,315	5,347

There were no Returns for the following months: June, July, August, September, October, November.

APPENDIX II (c).—MONTHLY STATEMENT, WHEAT (DURUM): JANUARY 1ST TO DECEMBER 31ST, 1929.

Month	Grades					Total Graded	Rejected				Total Rejected	Total Received
	K1	K1 S.W.	K2	K2 S.W.	K3		Wet	Musty	Weevily	Other causes		
January ..	3	2	3	..	..	8	..	..	..	..	..	8
February ..	459	..	466	..	99	1,024	629	9	..	445	1,083	2,107
March ..	1	..	..	..	222	223	446	2	..	1	449	672
April ..	228	..	..	..	..	228	435	8	..	1	444	672
July ..	..	..	87	9	..	96	..	..	16	..	16	112
September ..	..	120	..	5	..	125	..	4	5	..	9	134
Totals ..	691	122	556	14	321	1,704	1,510	23	21	447	2,001	3,705

There were no Returns for the following months: May, June, August, October, November, December.

APPENDIX II (d).—WHEAT GRADED AT MAIZE CONDITIONING PLANT, ALL VARIETIES.
—JANUARY 1ST TO DECEMBER 31ST, 1929.

Month	Grades				Total Graded	Rejected				Total Rejected	Total Received
	1	2	3	3 S.W.		Wet	Musty	Weevily	Other causes		
January ..	3,649	75	..	..	3,724	..	1	..	..	1	3,725
February ..	637	..	..	..	637	..	..	..	1	1	638
March ..	6,278	920	2	..	7,200	..	..	..	5	5	7,205
April ..	4,677	..	2	..	4,679	..	..	..	..	..	4,679
May ..	266	1,207	..	..	1,473	..	..	..	..	..	1,473
December..	..	122	..	..	122	..	..	..	1	1	123
Total..	15,507	2,324	4	..	17,835	..	1	..	7	8	17,843

There were no Returns for the following months: June, July, August, September, October, November,

APPENDIX II (e).—WHEAT MONTHLY STATEMENT. GRADING, ALL VARIETIES, INCLUDING MAIZE CONDITIONING PLANT: JANUARY 1ST TO DECEMBER 31ST, 1929.

Month	Grades					Rejected				Total Rejected	Re-bagged	Resewn
	K1	K1 S.W.	K2	K2 S.W.	K3	Total Graded	Wet	Musty	Weevily	Other causes		
January..	4,339	2	277	..	64	4,682	1,006	37	..	38	6	..
February	3,495	..	1,657	..	1,100	6,252	2,514	146	..	1,013	3	..
March ..	9,822	..	2,097	..	655	12,574	7,242	147	..	244	3	162
April ..	6,802	6	488	..	8	7,304	3,503	45	..	113	9	4
May ..	375	..	2,460	..	95	2,930	1,496	..	..	4	..	6
July ..	..	..	87	9	..	96	..	..	16	..	..	..
September	..	120	..	5	..	125	..	4	5	..	..	..
November	1,351	..	..	..	1,351	..	..	..	..	..	1	14
December	..	..	122	..	..	122	135	..	..	1	..	8
Totals	26,184	128	7,188	14	1,922	35,436	15,896	379	21	1,413	22	194

There were no Returns for the following months: June, August, October.

APPENDIX II (f).--SUMMARY OF MONTHLY STATEMENTS, WHEAT: JANUARY 1ST TO DECEMBER 31ST, 1929.

Variety	Grades						Rejected			Total rejected	Total received
	K1	K1 S.W.	K2	K2 S.W.	K3	Graded Total	Wet	Musty	Weevily	Other causes	
Equator	8,595	..	3,251	..	1,019	12,865	12,517	291	..	577	26,250
Kenya Governor ..	1,391	6	1,057	..	578	3,032	1,869	64	..	382	5,347
Durum	691	122	556	14	321	1,704	1,510	23	21	447	3,705
At Maize Conditioning Plant	15,507	..	2,324	..	4	17,835	..	1	..	7	17,843
Totals	26,184	128	7,188	14	1,922	35,436	15,896	379	21	1,413	53,145

Month	Fruit, lb.	Fresh Fish, lb.	Cured Fish, lb.	Cheese, lb.	Offal, lb.	Poultry, dozen	Butter, cases	Beef, quarters	Mutton & Pork, carcases	Eggs, dozen	Ham & Bacon, lb.	Vegetables, lb.	Other Commodities
January ..	8,694	1,534	3,406	224	208	..	513	14	31½	..	..	1,452	
February ..	5,546	1,857	4,776	287	60	..	286	16	6	..	..	612	
March ..	18,042	403	3,944	..	..	..	118	12	10	..	..	988	
April ..	12,035	842	5,443	..	300	..	42	8	23	..	..	366	
May ..	16,609	2,108	4,948	..	800	5½	76	31	29	..	..	..	10 Drums : 60 gallons Beer.
June ..	21,227	2,445	6,613	56	100	..	96	6	4	..	80	108	
July ..	12,892	3,801	4,998	..	590	..	129	19	12	..	..	..	20 lb. Lard ; 50 lb. Yeast ; 10 lb. Orange Peel and Walnuts
August ..	21,931	6,820	2,116	112	707	2	140	48	32	..	85	112	62 lb. Cream.
September ..	4,599	5,394	7,938	503	1,735	3	92	36	19	..	45	..	
October ..	6,645	5,031	6,656	508	234	..	197	15	6	..	33	..	480 lb. Margarine.
November ..	8,509	1,375	9,069	667	384	18	275	41	20	..	292	..	
December ..	18,351	247	5,083	1,680	410	20½	341	55	19½	270	157	64	3 bottles Milk.
Totals ..	155,180	31,857	64,990	4,037	5,528	48½	2,305	301	212	270	692	3,702	

APPENDIX L.

REPORT ON LOCUST INVASION.
SECOND HOPPER CAMPAIGN CONTINUED.

In January, 1929, work in all infested areas became intensified, and fresh hopper areas were discovered in Turkana and on the Coast. Eight more trucks were secured, and fifteen more locust officers. The Public Works Department very kindly permitted the Administration to utilise the services of the Road Engineer in Turkana with a squad of 400 boys to cut tracks and destroy hoppers. Through this, together with the efforts made by the Turkana people themselves, and the transport, officers and materials sent up, considerable destruction of hoppers was quickly effected. By the end of the month operations were in full swing near the Sudan Border, over the Uganda Border and along the shores of Lake Rudolph.

Fortunately, Marakwet was clear, but a scouting officer had to be employed almost the whole time to watch for outbreaks. Between Southern Turkana and Ravine good work was done in destruction. At the same time, tracks were cut and crossings of rivers and dry stream beds were made so that labour, materials and officers could move about readily. As operations came to a close in Southern Turkana, natives did excellent work on young flying swarms by ringing them with fire. Similar operations were undertaken in Kapeddo, with good results. The maturings in Kerio Province were inconsiderable, and every credit is due to the Administration for the work done. Mr. Evans, District Commissioner, was in control, his work being mainly the arranging for supplies, the movements of officers, and the general co-ordination of the effort. When the campaign ceased it was deemed advisable to continue for two to three weeks the work of bush cutting and road conditioning, as it was anticipated that further hopper swarms would have to be dealt with in May and June, so that the work might be more extensively and expeditiously undertaken.

Operations in the Kerio Province ceased at the end of February, when all staff was withdrawn except two; Mr. Mackenzie was left in Turkana for scouting, and Mr. Arnold in Baringo for the same purpose. The cost of the Kerio (Suk-Turkana) campaign was Sh. 68,840, or £3,442.

UKAMBA PROVINCE.

In Kitui, the Administration and staff under the direction of Mr. Emley, District Commissioner, had been very active. Laying areas were cleared of bush, so that hoppers could be destroyed rapidly as they hatched out. Some effort at digging up eggs was made, chiefly where eggs had been laid in *shambas*. The bush was laid to act as traps. Apparently natives were able to concentrate laying by driving flying locusts together when lethargic.

The organisation in this area of 18,500 square miles was almost complete, and in addition to sixteen locust officers, the Administration was assisted by missionaries and others. The native population turned out well; at one time over 20,000 were daily at work. Such a large effort was made, as it was desired by the people to restrict the use of spray and bait to the less populous areas.

The Voi district was also very well handled. Here also, natives cleared the egg areas and, whilst the numbers employed were not so great as in Kitui, a very large number turned out. In this destruction the Kenya and Uganda Railways used the locust poison train, both on the Voi-Kahe branch and on the main line as far west as Masongaleni. This train, mentioned above, when used did excellent work. This area, which was managed by the District Commissioner, Mr. Jennings, was supplied with eight locust officers, three trucks, one motor cycle, and ample supplies of pumps and so forth.

In the Masongaleni-Tsavo area, three locust officers, with two tank trucks and equipment, operated for some time. At the same time, Mr. Crawford scouted along the Chyulu Range and into the Masai Reserve. The operations conducted by the Administration of Ukamba, under the general direction of the Provincial Commissioner, Mr. Campbell, were conducted in a very practical and successful manner. In Kitui, particularly because the large population preferred to beat and burn rather than have poison and bait used on their grazing, the laborious method of beating was the main form of destruction used. Whilst it is the habit of some to scorn such an almost obsolete method, it must ever be remembered that we are working with the goodwill of the people and utilising the resources of the country to as large an extent as possible. As the use of spray and bait is demonstrated, and natives find that the method is practically without danger to man or beast, it is feasible to introduce it, and finally the obsolete system is superseded. What may appear to be out of date and is the

subject of adverse comment by people who do not understand the circumstances of each case, is of value, and it must be remembered that, when people are faced with work which has to be got over within a short space of time, every possible means is explored and utilised.

The field costs incurred in Ukamba Province were :—

Kitui, Sh. 53,502; Machakos, Sh. 9,898; Voi, Sh. 34,517; a total of Sh. 97,917, or £4,895/17/0.

THE COAST.

Kilifi and Malindi.—This district was in very capable hands, and much good work was done, resulting in a practical clearance of the area. The District Commissioners and their assistants were constantly in the field effectively directing the work. Two trucks, four locust officers, and supplies were sent.

Tanaland.—Remembering the nature of the communications, the work that was done by the Administration in this area was creditable. Three officers were sent. On the whole, the work which fell to be done in the Coast areas was well done, and with a minimum of difficulty. One would express the thanks of the Department to the Provincial Commissioner, Coast (Mr. Montgomery), for the way in which his staff carried out this heavy additional work, and for the way in which he handled the locust staff, moving them from place to place expeditiously, as the situation demanded.

The field costs for the whole Coast, Digo to Tanaland, were Sh. 28,998, or £1,449/18/0.

NORTHERN FRONTIER PROVINCE.

Although good men were sent up with ample transport and supplies, the work done for the expenditure incurred cannot be compared with that done in Ukamba. Heavy rains, the absence of roads and of people, together with the fear that if spraying was carried out the Samburu might lose stock, all militated against success with the work. At the same time the labour recruited in Meru—some 2,000 in number—was not very efficient, due to the fact that they were working at a somewhat lower altitude than Meru. The Administration did what it could to help, good work in particular being done by Mr. Bader, District Commissioner, Barsaloi. The enormous extent of infestation in the Northern Frontier must have appalled the workers. An area of some 5,000 square miles was successfully dealt with. Fourteen locust officers, six trucks and ample supplies were sent up.

The field costs for the Northern Frontier Province and Meru were Sh. 55,128, or £2,756/8/0.

MASAI RESERVE.

The work here consisted mainly of scouting, although hoppers were dealt with near Rombo. For some reason, the Masai people were not very helpful, possibly because the region in which hoppers occurred was somewhat remote from their then grazing grounds. Three officers, two trucks, and one motor cycle were employed in the area, and the time spent there was three weeks.

The field costs in the Masai Reserve were Sh. 7,907, or £395/7/0.

No details of the number of swarms destroyed have been kept, for the simple reason that as a number it has no value, and the area which hoppers cover varies with the time of day and the size and condition of insects.

For purposes of classification it has been decided to state the degree of infestation of an area in the form of a percentage of the whole area.

If one per cent of a district is covered by hoppers, the degree is heavy, if a tenth of one per cent, the infestation is light. Even this gives no real conception of the work to be done, because a light infestation in one district may be as difficult to handle as a heavy one elsewhere. In fact, there is no accurate means of recording the amount of work done except more officers be employed for the purpose of getting these records. Our endeavour has been to eliminate all staff not actually at work on hopper destruction, although we have recognised the necessity of providing one officer at least in a suspected area, so that information will come in if the area becomes infested, and also the provision of control officers in charge of groups. Laying locust swarms have the habit of proceeding darkly on their work, and gravid swarms may come into an area, lay and depart undetected, particularly if there is no one moving about the district to secure this information.

We have gone on the plan of suspecting an area in which we have found gravid locusts, and working over it carefully to find eggs and finally hoppers. We have then decided whether more staff is needed by taking into account the size and frequency of gravid swarms met with, the number of laying areas known and their probable size, and also the pace at which laying areas become hopper areas.

In addition to contact spraying, baiting both with poisoned dung, sisal waste, and poisoned hoppers, was carried out, but until the excessive fear of poisoning stock dies out of the native mind, it will be a difficult matter to do the best work under all circumstances.

FLYING SWARMS FROM THE 1928-29 HOPPER INFESTATION.

The flying swarms of pink locusts which arose from the undisturbed areas in the Northern Frontier and in Tanaland flew south on January 23rd. One section consumed immature crops in Meru and in Embu, a small off-shoot moving through Fort Hall. The vast majority made a huge sweep southwards and entered Tanganyika Territory in a series of waves about the end of January and early February. There, damage was done to native crops, and the swarms reached a point well below the Central Railway.

Swarms which arose in Northern Turkana and from Karpeddo appeared to enter the Plateau and Trans Nzoia and to move south. Two months later maturing swarms came northwards, and appeared first in the Voi district and over the Masai Reserve. They also moved north through Kisii country.

Concentrations of locusts appeared in the Nandi country, at Thomson's Falls and at Ngobit in the Laikipia Plateau.

Wheat crops were eaten in settled areas, sisal was damaged, coconuts and bananas were stripped, and fears were entertained for the coffee plantations, which fortunately had finished flowering when the locust swarms returned.

Scouting officers were employed continuously, and reliable advance information was secured regarding general direction of flight, maturation, density and probable date of laying.

During the swarming season, efforts on an experimental scale were made to clear up swarms by means of flame-throwers, the use of which had been strongly advocated. One's scepticism regarding this means of destruction was amply justified, and expenditure was curtailed as much as possible. The organisation, however, reinforced the scouting work and the destruction effected was advantageous to that extent.

Weekly Locust Reports have been issued since November, 1928, in which details of action taken and contemplated have been published. It is not therefore proposed to write lengthy reports which are merely a condensation of the reports already issued.

FUNDS.

The total amount spent in 1928 was £20,988, of which £6,515 was expended in the first campaign (Gilgil area), and £14,473 on operations in the first two months of this, the second, campaign in 1928 (this sum includes three months' scouting between the first and second campaigns).

A further sum of £25,800 was voted for the finish of the second campaign, January and February, 1929, and for the continuation of scouting. These sums include all capital expenditure for trucks, pumps, surplus stocks of arsenite, water drums, tentage and camp equipment, the amount thus expended being 29 per cent of the total vote.

THIRD HOPPER CAMPAIGN.

The scouts who were operating in all the possible areas of infestation kept this office well supplied with information regarding the condition of swarms, and towards the end of April laying was about to take place in the following districts: Masai Reserve, Machakos, Voi, Gilgil, Embu, and the Kerio Province generally. The flame-throwing units who were in the field were withdrawn, and these units formed the nucleus of an intensive scouting effort in the Masai Reserve, Voi, Machakos and Kitui.

The District Locust Officer in the Naivasha and Gilgil areas, and the District Locust Officer for Nakuru were still scouting for laying areas. Further scouting staff was put in the Baringo district. Other arrangements were made to fill out the skeleton organisation with staff, equipment, and so forth.

A locust train was sent to the Voi-Kahe line, and very soon laying areas were verified, and hatching commenced in the Voi district. Before the middle of May, twenty-five fully equipped trucks and thirty-eight locust officers were in the field. Further staff was being enrolled. By the end of May twenty-eight trucks and forty-eight officers were working. After fourteen days' work in the Gilgil area, which was reported as having 15,000 acres of laying area, the whole infestation was under control, and the staff was reduced to two officers. The Kitui infestation and the Machakos infestation were cleared up in, possibly, a shorter time than this, and the staff was sent by road to Turkana, where laying was still continuing.

In Southern Turkana, laying was reported as being general over the district, and hoppers again took only thirteen days to appear after laying had taken place. At the same time (the end of May) hopper areas were found in Karamoja (Uganda), and the Uganda Government was asked to co-operate. It was also reported that the Southern Sudan was infested.

In view of the intense infestation of the Kerio Province, it was deemed wise to make a strong effort to enrol people, particularly in the Trans Nzoia, who were acquainted with the conditions in Suk, North and South Turkana, and also in Eldoret for Elgeyo and Marakwet.

By the 15th June, there were over fifty officers operating in the Kerio Province, and it was just about that time that hatchings from the main layings were in full evidence, although not then complete. Spraying and bran-baiting were being used extensively, and in North and South Turkana destruction of the hoppers was effected by burning.

On June 15th an extra locust train was assembled in Nairobi and despatched to the Magadi Line, being fitted with searchlights, which allowed of night operations. By re-arrangement of the train service, this train was operated twice per day—once at night and once in the day-time—blocking the line for twelve hours out of twenty-four. A total of fourteen officers with, at one time, 250 natives, were working in the Masai Reserve, and after a month's work, that is, by the end of June, it was considered that the infestation was under control, and the majority of the hoppers remaining had practically all been destroyed in an area of 6,000 square miles by the end of July.

At the beginning of July the position in the Kerio Province showed that in Elgeyo and Marakwet very good work was being done, as also in Suk, whilst the news from Baringo and North and South Turkana was not encouraging. An effort was made from Kitale to equip officers for work in Karamoja, and although they arrived somewhat late, they were able to effect considerable destruction. It is unfortunate that, at the beginning of July, fresh hopper bands were being encountered in the Voi district from late hatchings, and the staff operating in that district had to be reinforced. Practically all the area between the railway line and the Athi River is so densely covered with bush that roads and paths had to be cut to gain access to the hopper bands, which were very numerous. It was also found impracticable to reach an infested area near Lake Jipe in

sufficient strength completely to clear the area of hoppers. Thus, in the south zone, i.e. Masai and Voi areas, a small proportion of hoppers reached maturity, but not in large numbers. Further, it was found that in the Masai Reserve, at least one inaccessible plateau near Mara had produced hoppers which were left unmolested, and which were actually not reported.

In the middle zone, from Njemps to Naivasha, the hopper infestation was practically cleared up, but again, in the Uasin Gishu-Masai Reserve below Ravine, difficulties were encountered and small patches of locusts reached maturity, although a large proportion of flyers were subsequently baited. In the north, i.e. from about Marrigat to the Sudan Border, exclusive of Suk, Elgeyo, and Marakwet, but including North and South Turkana, Karamoja, and the northernmost parts of Baringo, it was not anticipated that complete destruction would be effected.

The hatchings in the Northern Frontier Province were on a very small scale, and the Locust Scout was able to clear two valleys and a portion of a third before he met his untimely end; also two officers were employed on the Laikipia Plateau. Thus it was expected that flying swarms would arise in the north, and that small swarms would arise in the south, and as laying had proceeded from south to north, these would move in a general northerly direction. Any escapes from Tanganyika were expected to enter the Colony.

By the middle of July many areas in Baringo were reported clear, but fresh hatchings were continually taking place, and a portion of the staff from the Gilgil-Naivasha area, which was now becoming clear, was moved up to assist in overcoming these. On the 23rd July, three officers were also transferred from Voi to the Kerio Province.

At this time, namely the middle of July, a hundred officers were in the field, and this number had to be supplied with bran and arsenite, also posho for native labour, which proved a severe tax on the transport, owing to the condition of the roads due to heavy rains. It was also necessary to employ road gangs to keep transport routes open.

Very large hopper bands were reported as being in Abyssinian Territory; one heavily-infested area being thirty miles north of Moyale.

On the 1st August reports were received of flying swarms passing over Nandi, Kipkarren, Donyo Sabuk, and Lake Naivasha, but none were reported as of great size, and no damage to crops was indicated.

By the 15th August many areas in the north were reported clear of hoppers, and in others the hoppers had arrived at the flying stage, and although it was not expected that operations would definitely cease, it was felt that to maintain such a big staff in the field was unnecessary. Consequently, the services of a number of locust officers were dispensed with. Nature was also very materially assisting in the destruction, disease appearing among both hoppers and flying locusts. Intense cold in Elgeyo and Marakwet had arrested the movement of hoppers, and enabled countless numbers to be destroyed, both by baiting and beating.

Many methods of destruction had been employed during the hopper infestation—local conditions, labour and water supply being the main determining factors. Contact spraying was found, on the whole, to be a good form of destruction. Beating was resorted to when the labour supply was far in excess of the plant. Bran baiting proved deadly when the prevailing conditions, such as short-grass or grassless country and scarcity of water were encountered, and burning where sufficient dry material existed, proved an economical though slow method to employ.

About the 15th August it was, however, disquieting to receive reports of new layings in South Turkana, on both banks of the Turkwell and Kerio Rivers, and in Baringo. This was responsible for the, up to then, extraordinary state of having newly-hatched and old hoppers, pink fliers and laying locusts in the same area. The gravid swarms were reported as having entered from the Sudan, and also from round the southern end of Lake Rudolph. The laying areas were well scouted by the officers who were clearing up the remnants of the previous hatching.

The swarms departed in a north-easterly direction into the Northern Frontier Province, but no trace of laying has been reported from there.

In North and South Turkana and in the Karpeddo areas, young hoppers began to appear at the end of August, and efforts were made to clear the areas rapidly. Karpeddo was cleared up in two weeks, whilst on the Turkwell River and in

North and South Turkana the infestation was so intense that complete destruction was not possible. This, too, was rendered difficult by the locally imposed restriction on baiting and spraying near the Turkwell River itself, as that is the sole water supply for a very large area. The river normally is really a series of very shallow pools of small dimensions, so that some pollution may have been possible, although it did not appear a valid reason for the prohibition of baiting or spraying, as the hoppers and the bait would be carried into the river only by heavy rain, when the dilution would be enormous. During all this period the river was in high flood.

The Karpeddo infestation covered an area of 532 square miles, and proved not to be severe. Heavy rain fell; only 314 acres of actual hoppers were baited in eight days; the balance was destroyed by weather conditions and the flocks of birds which at that time were large and numerous.

The North and South Turkana infestations were not completely overcome. The Turkwell River hopper areas covered 600 square miles. Staff and transport had to be reinforced, and the infestation, which amounted to practically 1 per cent of the area involved, was reduced to .15 per cent before young fliers were found. These in some cases were successfully bran baited. The balance, comprising three large swarms, flew in a north-easterly direction.

It is opportune to mention the heavy additional work which fell on the shoulders of Administrative Officers, particularly in Voi (Mr. Jennings) and in Kerio Province, where the staff, under the direction of Mr. Stone, Senior Commissioner, carried out a great deal of work effectively.

By October 10th, 1929, staff was reduced, and the distribution was as follows:—

Masai Reserve.—One scouting officer.

Northern Frontier Province.—Three scouting officers.

Baringo.—Two scouting officers, one road officer.

Marakwet.—One scouting officer.

West Suk.—One scouting officer.

North and South Turkana.—Two scouting officers, two road officers.

FOURTH HOPPER CAMPAIGN.

At the end of October, 1929, from the information supplied by locust scouts, and wireless reports from Administrative Officers in the Northern Frontier Province, it was indicated that further locust swarms had invaded the Colony from the north and that these swarms were fast approaching the laying stage.

The scouts operating in the Turkana Province and Baringo reported a small amount of laying, but as this was considered to be of no consequence, these officers were either withdrawn or concentrated on the evacuation of stores and equipment from these areas. Three officers were for a period employed on road-making, in order to improve communications. A track has now been constructed from Marrigat to Karpeddo, and on to the Kerio River, which it meets about thirty miles from Loperot, the new Administrative Headquarters for South Turkana. This track will greatly facilitate future operations, as will also the road cut from Kabarnet down into the Kerio Valley towards Tambach.

By 31st December, 1929, no locust staff and but little equipment remained in the Turkana Province or Baringo.

Meanwhile, the swarms from the north-west had laid in the Northern Frontier Province, Meru, Embu, Kitui, Donyo Sabuk, Machakos and Voi. Several swarms died out in the Southern Masai Reserve.

During November and early December further staff was enrolled and distributed to infested areas, but at no time were there more than twenty-seven locust officers in the field, including those in Turkana and Baringo employed on scouting, etc.

THE NORTHERN FRONTIER PROVINCE.

Prior to the commencement of oviposition, three locust scouts had been posted to this Province so that laying areas had been located before hoppers hatched. Later the staff was increased by four locust officers, five lorries and five native drivers, which gave a total of one locust control officer and six officers, five drivers and eight lorries to carry out the operations.

The area of infestation is from Lasamis all down to the Guaso Nyiro at Archer's Post, thence west to Uaraguess and Nanteddu.

Bran-baiting operations commenced on 29th November, 1929, but were seriously hampered by lack of labour and transport difficulties, due to severe weather conditions. Both the Provincial Commissioner, Northern Frontier Province, and the District Commissioner, Meru, were asked to supply labour, the former obtained thirty Turkana consisting of one paramount chief, lesser chiefs and headmen, who naturally refused to work, whilst the District Commissioner, Meru, was unable to give assistance. The control officer has therefore to rely on what casual labour he can produce himself, which is very little. Fortunately, the infested area is small, being only about 900 square miles in extent, so that even with the little assistance given, locust officers, by the use of bran bait, are carrying out successful operations.

Hoppers were reported about the 15th December in the vicinity of Marsabit, and one officer has been sent from Archer's Post to deal with them. The infestation is not heavy, and owing to the prompt assistance given by the District Commissioner, Marsabit, the position will soon be under control.

EMBU.

The control of all anti-hopper operations in this district has been undertaken by the local Agricultural Officer, who has under him four temporary locust officers. Laying had taken place at the end of October in Lower Emberré, parts of Upper Emberré, and along the banks of the Tana and Matongo Rivers. Bran-baiting operations are being carried out with success, whilst labour is plentiful and the natives are very keen to assist, turning out on their own and destroying hoppers by beating.

KITU.

Early in November, one locust officer proceeded to the northern parts of this district, and shortly after his arrival he reported laying at Katse, Gai, Mivukoni, Tesikuru, Ndatani, and Ukazzi. Hoppers began to appear at the beginning of December and three more locust officers were posted. Two other officers have been continuously employed transporting poisoned bran from Nairobi.

At a later date hoppers were reported at Mui, Nu, and on the Yatta Plains near Kampi ya Faro; to deal with this later infestation, three more officers have been sent into the district. Bran-baiting exclusively is being used for the destruction of the hoppers and proves very successful.

DONYO SABUK.

A laying area of 300 acres was discovered on the Nzene Estates, and when hoppers appeared an officer with bait was sent to deal with the situation, which he reported clear within one week.

MACHAKOS.

At first one, and latterly two, officers were operating in this district, where hoppers had hatched out in the Katheka and Meanyani locations. By the 20th December, all hoppers were destroyed and the staff was transferred.

VOI.

Scattered laying in this area was reported by the District Commissioner on 18th November, and a locust officer was despatched early in December, soon after which hoppers appeared at Voi, Ndi, Mbololo. Bran-baiting operations are now taking place. On the 11th December, the Railway Authorities were asked to supply a locust train, which was assembled immediately and proceeded with another locust officer to Voi. This train is operating on the main line from Mile 96 to Mile 140, and on the Moshi line between Voi and Maktau.

The prospects for 1930 would seem to be favourable, and unless many flying swarms move northwards up the Rift Valley next March and April, the hopper infestation in June is likely to be slight. It is possible that Turkana may be infested again from regions in the vicinity of Lake Rudolf to the north, but it is more than possible laying regions are sufficiently foul and disease-ridden, and birds sufficiently numerous, to check any undue multiplication of the gregaria type.

In conclusion, it is desired to thank all those who are helping in the operations of this campaign, particularly the Administrative Officers in the various Districts, and the Agricultural Officer, Embu.

E. HARRISON,
Deputy Director of Agriculture.

APPENDIX M.

**ANNUAL REPORT OF THE
ASSISTANT AGRICULTURAL OFFICER IN
CHARGE, NAKURU DISTRICT, 1929.****STAFF.**

I arrived at Njoro from home leave on April 18th to take up my duties as Agricultural Officer, Nakuru District.

Mr. R. Noble assisted me during the period April 24th to May 12th.

Native staff consisted of two plot attendants and eight labourers, supplemented from time to time with labour kindly lent by the Plant Breeder and by the owners of farms at which work was carried out.

WEATHER AND RAINFALL.

The rains, which were very local, broke late, and high winds were experienced during April, May and June. June, which was a dry month, was followed by comparatively heavy rain during July. The rainfall during August, September, and October was poor. Rainfall improved during November and December. Rainfall was extremely patchy, and was below the yearly average. It was, however, sufficient to ensure good crops in the Subukia, Solai, Rongai, Molo and Mau areas.

TRAVELLING.

5,188 miles were covered by motor car on Government service, 291 miles being travelled for the Senior Coffee Officer on coffee inspection. All parts of the district were visited during the period under review, and a tour was made in the Fort Ternan and Koru districts. The number of days spent on outside work in the district was 143.

LECTURES.

Informal lectures were given to Farmers' Associations at Njoro, Molo, Fort Ternan, and Muhoroni; in addition, lectures were arranged for the Assistant Agricultural Chemist and the Mycologist at Rongai, Solai, and Nakuru respectively.

Addresses have also been delivered by the Plant Breeder from time to time.

ADVISORY WORK.

Advisory work was carried out both while on tour and by correspondence.

EXPERIMENTAL WORK.

Prior to my arrival experiments were devised, plots were pegged out and liming and sub-soiling completed. I was instructed to complete the layout and carry on the experiments. Plots were sited at the following places :—

Rongai	...	...	...	2
Pipe Line	...	...	...	1
Olpunyata	...	...	...	1
Menengai Slope	...	...	...	1

Rongai.

Plots were laid down on three-year old and nine-year old land on Mr. J. E. W. Whitmore's farm as follows :—

1. Green Manure Strip Trial.
2. Latin Square, Fertiliser Experiment.
3. Rotation I.
- Rotation II.
4. Observational Stripes of various Legumes and non-Legumes for Green Manuring.

Plot A., nine-year old land.—Green Manure Strip Trial.

The area was divided longitudinally into three portions, viz. :—

1. No treatment.
2. Ground lime applied at the rate of one ton per acre.
3. Sub-soiled.

These strips were transversely divided into nine strips, two being planted to a legume, viz. Cowpeas, *Vigna* sp., two being planted to a non-legume, viz. Buckwheat, five being planted to maize.

These divisions gave :—

Buckwheat—

- No treatment.—Two plots.
- Limed.—Two plots.
- Sub-soiled.—Two plots.
- Total.—Six plots.

Cowpeas—

- No treatment.—Two plots.
- Limed.—Two plots.
- Sub-soiled.—Two plots.
- Total.—Six plots.

Maize—

No treatment.—Five plots.

Limed.—Five plots.

Sub-soiled.—Five plots.

Total.—Fifteen plots.

Each plot measured 22 x 11 yards.

Plantings.

Buckwheat.—The crop was broadcasted at the rate of 35 lb. to the acre, germination was good and the crop grew well, being turned under in the flowering stage.

Planted 4-5-29; turned in 2-7-29; approximately sixty days from time of planting.

Cowpeas.—This crop was planted in drills two feet between rows and one foot in the row. Germination and growth were good. The crop was allowed to grow on until some seed pods had formed; the green matter was still in excellent condition for turning in. Nodule development on the roots was good.

Planted 4-5-29; turned in 3-9-29; 120 days approximately from time of planting.

Maize was planted on the check row system, 3 ft. x 3 ft.; four seeds were planted to a hill, being eventually thinned out to two plants per hill. The crop grew well, being particularly free from disease. Corn ear worm was observed. A 5 per cent infection of ear rot was noted at time of harvesting.

Planted 30-4-29; harvested at the end of November.

Soil variations, etc.

Considerable variations in the soil were noted over the strips. Weighings were taken, the following procedure being adopted in the case of green crops: Yard square wires were put down, and the produce within the wires was weighed as green matter.

In the harvesting of the maize, the outside row of each plot was discarded to obviate border effect. No significant difference in growth could be noticed by eye between any of the three treatments.

Unfortunately, owing to the situation of the plot being liable to wash, and insufficient labour being available to trench round the entire plot, four plots were damaged.

Results of weighings are appended below, and give some idea of what yields may be obtained from nine-year old land when a level and an even stand of maize is obtained, and some idea of what amount of green matter from cowpeas and buckwheat is produced.

	No Treatment	Limed 1 ton per acre	Subsoiled
Cowpeas ..	9 tons Green Matter	8.10 tons	10.8 tons per acre
	9.45 " " "	8.64 "	12.15 " "
Buckwheat ..	7.5 " " "	7.5 "	8.5 " "
	7.5 " " "	7.5 "	8.5 " "
Maize .. 1	11.52 bags per acre	12.65 bags	16.13 bags "
2	14.60 " " "	16.10 "	16.80 " "
3	15.60 " " "	13.60 "	15.00 " "
4	17.50 " " "	15.40 "	17.50 " "
5	16.40 " " "	16.25 "	17.80 " "

Plots 1 and 2, no treatment, and 3 and 4 subsoiled were damaged by wash.

Latin Square Fertiliser Experiment.

A four-sided latin square with plots randomised, was laid down, treatments being as follows:—

A.—No treatment.—Four plots.

B.—Boma manure, approximately 8 tons per acre.—Four plots.

C.—Superphosphate 100 lb. per acre.—Four plots.

D.—Seychelles guano 300 lb. per acre.—Four plots.

Crop.

Maize was planted on the check row system, 3 ft. x 3 ft., two plants being left to each hill.

Each plot measured 16 x 16 yds., the outside row being discarded in order to obviate border effect. Unfortunately, owing to the situation of the plot being liable to wash and insufficient labour being available for trenching purposes, the plots were damaged by wash during unexpected heavy rain, no accurate results could be obtained. From observations taken during growth the treated plots showed stronger and healthier growth than the untreated plots. There was a marked difference between those treated with boma manure and those untreated.

*Rotation Plots.**Rotation I—*

Maize—Ground Nuts.

Ground Nuts—Maize.

Each plot measured 22 x 33 yards. No treatment was applied.

Maize planted 30-4-29; harvested end of November; yielded 15.70 bags per acre; the yield is good and due to obtaining a good stand of plants.

Ground Nuts.—This crop was planted on the 4-5-29, in rows, 3 ft. between rows, and 1 ft. in the row.

The crop grew well and set seed freely, but had failed to ripen by the end of the year. The crop was free from disease.

Rotation II—

Maize—Beans—Barley.

Beans—Barley—Maize.

Barley—Maize—Beans.

Maize grew well and yielded 16.39 bags per acre. Barley planted 20-5-29, harvested 20-9-29, was disappointing, yielding only 4.10 bags per acre; broadcasted at the rate of 75 lb. per acre, it was treated with formalin, and showed no signs of smut. The sample was only a good feeding one.

Beans.—The variety used was Rose Cocos.

Planted 9-5-29, harvested 20-9-29, 3 ft. x 9 in.; yielding 6.92 bags per acre.

Nodule development on the roots was fair.

Rainfall during the growth of maize was 29.36 in., the greatest rainfall being in July—6.95 inches.

Plot B, three-year old land.

The layout of the plots was as in Plot A, viz. :—

1. Green Manure Strip Trial.
2. Latin Square Fertiliser.
3. Rotation I, Rotation II.
4. Observational strips of different legumes and non-legumes for green manuring.

Green Manure Strip Trial.

Buckwheat broadcasted at the rate of 35 lb. per acre; planted 4-5-29, turned in 4-7-29; approximately sixty days. Seed germinated well, and good growth was made.

Cowpeas were drilled 2 ft. apart and 1 ft. apart in the row. Growth was excellent and nodule development on the roots was good.

Weighings are appended below.

There was again a considerable variation of soil between strips, and no definite difference in growth between treatments was noticeable. Yields of maize were again good, chiefly attributable to the even stand.

Cowpeas produced excellent weights of green matter.

	No Treatment	Limed	Subsoiled
Buckwheat ..	9 tons per acre G.M. 8½ " " " "	8.75 tons 8.00 "	9 tons per acre 8½ " " "
Cowpeas ..	12.90 " " " " 14.31 " " " "	12.15 " 12.91 "	13.50 tons pr. ac. 15.66 " " "
Maize .. 1	21.60 bags per acre	21.60 bags	22.80 bags "
2	21.50 " " "	20.60 "	22.10 " "
3	17.50 " " "	16.80 "	18.10 " "
4	16.13 " " "	15.00 "	17.20 " "
5	16.80 " " "	15.49 "	17.70 " "
Average yield..	18.70	17.80	19.50

The accurate and statistical comparison of yields cannot be made from strips as in the case of a latin square, with plots randomised, but it appears that no response is obtained from the use of **lime**.

Latin Square—Plot B.

A four-sided latin square with plots randomised was laid down. Treatments were as follows:—

A.—No treatment.

B.—Boma manure, 8 tons approximately per acre.

C.—Superphosphate, 100 lb. per acre.

D.—Seychelles guano, 300 lb. per acre.

Crop planted, maize, 25-4-29; harvested first week in December.

Germination of seed was good and the crop grew well.
Result :—

Average yield	No treatment	Super-phosphate	Seych'ls. Guano	Boma manure	Mean	Standard error
Bags per acre ..	19.03	21.8	20.53	22.26	20.75	.30
In % ..	91.7	102.07	99.03	107.8	100	1.44

All the treatments gave increases in yields, which were statistically significant.

Application of 100 lb. superphosphate per acre gave a mean increase of 2.77 bags per acre over the mean yields of untreated plots.

An application of 300 lb. guano per acre gave an increase of 1.52 bags per acre. In this connexion, it must be borne in mind that superphosphate is a much more readily available manure than guano, which latter manure may have a residual value which will go far to compensate for the difference by its effect on the following crop.

Approximately eight tons of boma manure per acre gave a mean increase of 3.23 bags per acre.

The boma manure used was three years old, taken from an open boma, and, as is customarily the case, no litter had been added. Deterioration must have occurred, owing to the influence of sun and rain.

Fairly fresh manure containing litter and protected from the weather would no doubt have given higher increases. With the present low price of maize, it appears hardly profitable to apply fertilisers on this land, but it is noteworthy that the use of superphosphate produces nearly as great an increase as boma manure.

Here again the effects of manuring can only be judged fairly over a series of years, and organic manures exercise a beneficial effect on soil fertility as does no other class of fertiliser.

Rotation I—

Maize—Beans.

Beans—Maize.

Maize was planted check row on 3-5-29; harvested on 30-11-29; yielding 20.1 bags per acre.

The stand of plants was again good.

Beans were planted in drills, 3 ft. apart and 9 in. in the row. The crop grew well and yielded 7.10 bags per acre.

Rotation II—

Maize—Beans—Barley.

Beans—Barley—Maize.

Barley—Maize—Beans.

Maize planted 3-5-29; harvested 30-11-29; yielded 21.20 bags per acre.

Barley, broadcasted at the rate of 75 lb. per acre, was disappointing, yielding only 7.10 bags per acre; planted 15-6-29; harvested 15-10-29.

Beans, which at the first planting failed to germinate well, were replanted, 10-6-29, and harvested 10-10-29; yielded 5.02 bags per acre. The lateness in time of planting is probably responsible for the fall in yield as compared with Rotation I.

Rainfall during the growth of maize—28.67 inches; greatest rainfall was during July—6.18 inches.

Pipe Line.

Plots were laid down on the ash soil of the Pipe Line area. The layout of the plots was the same as at Rongai, with the exception of the latin square, which was varied.

Green Manure Strip Trials.

Buckwheat broadcasted at 35 lb. per acre; planted 11-5-29; turned in 17-7-29.

Cowpeas drilled 3 ft. x 9 in; planted 10-5-29; harvested 14-1-30.

It will be noticed that cowpeas are slower in growth at this situation, owing to difference in altitude.

Maize planted 10-5-29; harvested 14-1-30.

Weather conditions were not good, and the crop received a severe setback in June. Infection of head smut was observed, but the infection was small.

The growth of all crops was not so good as at Rongai.

		No treatment	Limed	Subsoil
Buckwheat ..		5½ tons G.M. per acre	5½ tons	6½ tons
		5½ " " "	5½ "	6½ "
Cowpeas ..		7.30 " " "	6.75 "	7.50 "
		6.48 " " "	6.00 "	7.30 "
Maize ..	1	6.91 bags per acre	6.91 bags	8.69 bags
	2	6.91 " "	6.91 "	8.90 "
	3	5.76 " "	5.76 "	7.89 "
	4	6.91 " "	6.91 "	7.89 "
	5	5.79 " "	5.76 "	7.89 "
Average ..		6.45 " "	6.45 "	8.25 "

No really marked differences in growth were observed between the treatments.

Latin Square.

A five-sided latin square was laid out. Treatments were as follows :—

A.—No treatment.

B.—Boma manure, 8 tons approximately per acre.

C.—Double superphosphate, 100 lb. per acre.

D.—Sulphate of potash, 50 lb. per acre.

E.—Double superphosphate, 100 lb., and sulphate of potash, 50 lb. per acre.

Crop.—Maize, planted 10-5-29; harvested 14-1-30.

Weather conditions were not good, and the crop received a severe setback during the dry weather in June.

Average yield	No treatm't.	Super-phos ph.	K2O	Super K2O	Boma manure	Mean	Stand'd. error
Bags per acre ..	7.05	9.46	8.56	8.18	11.6	8.97	.13
In per cent	78.5	105.3	95.4	91.2	129.0	100	1.44

In this experiment boma manure gave the larger increase, i.e. 4.55 bags per acre.

Superphosphate was again second, an application of 100 lb. per acre yielding an increase of 2.41 bags over untreated plots.

50 lb. per acre of sulphate of potash gave an increase of 1.51 bags per acre. A curious feature of this experiment was that 100 lb. superphosphate, plus 50 lb. of potash gave an increase of only 1.13 bags per acre. This apparently adverse effect of super plus potash should be investigated further. The use of potash should be tested at varying rates by means of a latin square.

Rotation I—

Beans planted 11-5-29; harvested 18-9-29.

Maize planted 10-5-29; harvested 14-1-30.

Beans yielded poorly— $2\frac{1}{2}$ bags per acre.

Maize yielded only 7.90 bags per acre.

Rotation II—

Maize planted 11-5-29; harvested 14-1-30; yield, 5.40 bags per acre.

Beans planted 11-5-29; harvested 18-9-29; yield, 3.00 bags per acre.

Barley—failure.

Barley, which was planted twice, proved a failure.

Olpunyata.

Plots were laid down on fifteen-year old land, and took the same form as at Rongai.

Green Manure Strip Trial.

Buckwheat planted 15-5-29, turned in 22-9-29, and Cowpeas planted 10-5-29, turned in 17-10-29, yielding green matter as follows:—

		No treatment	Limed	Subsoiled
Buckweat	..	$5\frac{1}{2}$ tons G.M. per acre	5 tons	$6\frac{1}{2}$ tons
		5 " " "	5 "	6 "
Cowpeas	..	$6\frac{1}{2}$ " " "	6 "	$7\frac{1}{2}$ "
		6 " " "	6 "	7 "

Maize.—The crop did not grow well, and was badly attacked by head smut, infection being as high as 20 per cent. All infected plants were removed and burnt. Cut worm attacked the plots soon after planting. Stalk borer infection was general throughout the plots. No comparative results could be obtained from the latin square or yields taken of the strip trial.

Rotation I—

Maize—Ground Nuts.

Ground Nuts—Maize.

Maize planted 10-5-29; harvested 23-1-30.

Ground Nuts planted 11-5-29.

This crop grew well and set seed freely, but was not ripe by the end of the year.

No yields of maize were taken owing to attacks of head smut and stalk borer.

Rotation II—

Maize—Beans—Barley.

Beans—Barley—Maize.

Barley—Maize—Beans.

Barley proved a failure.

Beans yielded only $2\frac{1}{2}$ bags.

This land had been continually cropped to maize for fifteen years.

The following varieties of Upland rice were planted in small strips for trial :—

1. Moering.
2. Poeloet.
3. Si Landjah.
4. Kading Kloeang.

Seed germinated well, but growth was poor, the crop failing to set seed.

Menengai Slope.

The layout of the plots was the same as at the Pipe Line. The land had been cropped for eighteen years.

Green Manure Strip Trial.

Buckwheat planted 9-7-29, turned in 10-9-29. This crop germinated well, but plants were a sickly green colour; the strips had to be replanted, and the crop was so poor that no weighings were taken.

Cowpeas.—This crop made fair growth only. Planted 9-5-29; turned in 10-10-29.

		No Treatment	Limed	Subsoiled
Cowpeas	..	7.0 tons G.M. per acre	7.0 tons	7.50 tons
		6.50 " " "	6.35 "	7.30 "

Maize.—Planted 10-5-20; harvested 30-1-30. The crop was considerably damaged by hail during the season.

		No treatment	Limed	Subsoiled
Maize ..	1	8.3 bags per acre	7.95 bags	9.2 bags
	2	8.3 " "	8.3 " "	9.2 " "
	3	8.6 " "	8.3 " "	9.8 " "
	4	8.98 " "	8.6 " "	10.14 " "
	5	8.98 " "	8.6 " "	9.8 " "
Average ..		8.6 " "	8.3 " "	9.6 " "

There was no obvious difference in growth between the treatments.

Latin Square.

A five-sided latin square with plots randomised was laid down. The treatments were as follows :—

A.—No treatment.

B.—Boma manure, approximately 8 tons per acre.

C.—Double superphosphate, 100 lb. per acre.

D.—Sulphate of potash, 50 lb. per acre.

E.—Sulphate, 50 lb., plus superphosphate, 100 lb. per acre.

Crop.—Maize, planted 8-5-29; harvested 29-1-30.

Weather conditions were not good, and rainfall was below average.

Av. yield	No Treat ment	Super-phos-phate	Sulphate of Potash	Super P.us Potash	Boma manure	Mean	Stand-ard error
Bags per ac.	7.16	8.70	7.21	8.37	11.46	8.44	.074
In per cent.	84.8	103.1	85.4	99.2	13.6	100	.87

On this soil, 100 lb. superphosphate gave an increase of 1.60 bags per acre over untreated plots; this mean increase did not approximate at all to the increase given by boma manure, which was 4.30 bags per acre.

There was no clear benefit from the application of 50 lb. of sulphate of potash per acre.

Superphosphate plus potash gave an increase of only 1.21 bags per acre, which is unprofitable.

Rotation I—

Beans—Maize.

Maize—Beans.

Beans planted 9-5-29; harvested 24-9-29.

Maize planted 7-5-29; harvested 30-1-30.

Yields : Maize, 8.10 bags per acre ; beans, 3 bags per acre.

Rotation II—

Maize—Beans—Barley.

Barley—Maize—Beans.

Beans—Barley—Maize.

Yields : Beans, 3 bags per acre ; maize, 8.10 bags per acre ; barley, 6.33 bags per acre.

Green Manure Observational Strips.

Small strips of various legumes and non-legumes were planted at each of the plots for observational purposes ; no weighings were taken.

Legumes.

Three varieties of Velvet Beans—

1. Common Florida,
2. Light Grey,
3. Tracy's Black,

were planted only at Rongai on nine-year old land. Planted 2 ft. 6 in. x 1 ft. on 21-5-29, they were ready to turn in on 10-9-29. The distances between the rows had been entirely filled up and growth was exceptionally good. Nodule development on the roots was excellent. Tracy's Black and Light Grey appeared to make better growth than Common Florida. The plants were allowed to grow on in order to see if they would set seed. Seed set well, but was slow in ripening. The plants produced a thick mat of green matter, 1 ft. 6 in. to 2 ft. high.

Lima Bean.

Red Spotted Madagascar Bean.

This crop did well at all situations, making growth equal to Velvet Beans ; it, however, took longer to grow at the Pipe Line than elsewhere. It was ready to turn in at $3\frac{1}{2}$ to 4 months. It set seed well, which ripened readily. Nodule development was good.

Njahi.

Made good growth at all plots, taking from 4 to 5 months. This crop was again slower at the Pipe Line than elsewhere.

Planted in rows, 2 ft. 6 in. by 1 ft. in the row, it fills up the distance well. It set seed well at all plots. Nodule development was not as good as Velvet Beans.

Field Peas.

Broadcasted at 50 lb. per acre; did well, but did not make the growth of any of the above-mentioned crops. They are ready to turn in at $2\frac{1}{2}$ months from time of planting. Nodule development was poor.

On a farm at Njoro, Grey Dun Peas, broadcasted at 90 lb. per acre, formed a dense mat of green matter 2 ft. 6 in. high.

Cowpeas.

Did well on all plots, making good growth. They are ready to turn in at 3 months from time of planting, but on the Pipe Line they require 4 months. They set seed freely, and even when the seed has been harvested the haulm is in a suitable condition to turn in.

They are best planted in drills 2 ft. apart, 6 in. to 9 in. being allowed between the seeds.

Yields of $15\frac{1}{2}$ tons of green matter have been obtained. Late planted crops did not give the growth that early plantings gave, although even when planted late growth was good.

Nodule development was excellent.

Rose Cocos and Canadian Wonder Beans.

Gave only fair growth, and in no way compared with the other legumes. Nodule development was poor.

*Crotalaria Incana.**Crotalaria Intermedia.*

Of the two, *Crotalaria Incana* proved the better. It is, however, small-seeded, and there is a danger of much of the seed being washed out under heavy rain. It takes approximately ninety days to reach the flowering stage. Growth and nodule development were good.

Crotalaria Jancea, Sun Hemp.

Was noticed to be growing well in a small plot on a farm west of Menengai. Seed had set freely, growth was good and nodule development was good.

*Non-legumes.**Buckwheat.*

Broadcasted at about 35 lb. per acre, did well; growth was good, but in no way comparable to cowpeas. Ready to turn in at sixty days. On fifteen-year old and eighteen-year old land at Olpunyata and Menengai growth was poor.

Kale.

This crop was tried, but proved a failure. It was observed growing well at Molo.

Niger Oil Seed.

This crop grew well at all plots, and was ready to turn in at $2\frac{1}{2}$ months. Growth was good and appeared equal to buckwheat. Late plantings did well, and it withstood dry spells of weather. Its chief objection is the size of the seed, but it could be broadcasted or sown with a fiddle.

Rye.

This crop did well and was ready to turn in at 4 months from planting; made excellent growth, but would be difficult to turn in with a disc plough; it could be turned in effectively with a mould board plough to which drag chains or thick drag wires were attached to the coulter and allowed to drag in the furrows. Drilled at 80 lb. per acre.

Sunflowers.

This crop made excellent growth and was ready to turn in at 3 months. The crop can withstand long dry periods and then recover. Its growth was good, even on the longer cropped land. It may be broadcasted or drilled, 1 ft. to 1 ft. 6 in between drills. This crop might be tried interplanted with some quick-growing legume, such as field peas, or a quick-growing variety of climbing bean.

Mtama.

Growth was slow, and if late planted would prove an excellent host for stalk borer, and is not considered suitable.

Oats.

This crop grew well, producing a mass of green matter, and appeared to be more suitable to turn in than rye, the stems being softer. It grew well on Pipe Line soil.

A mixture of horse beans, tares and field peas was observed at Molo producing a mass of luxuriant vegetation. This mixture should be very valuable at the higher altitudes, with their heavier rainfall.

GENERAL.

Maize.

Owing to the patchy rainfall, the crop in the district has been variable. Crops in the Solai, Olpunyata, Subukia areas were good, while Rongai has had only fair yields. The crop in the Nakuru and Njoro areas proved but light; this may be attributable to many causes: cut worm, poor rainfall at critical periods of the crop's life, the dry time in June and again during August affecting the yield. Where maize takes nine months to mature there is always a risk of low yields owing to dry periods. Though one would be adverse to advising farmers to go entirely out of maize-growing, the tendency will be to increase the acreage sown to wheat, since there is less risk of not getting a crop of wheat, owing to its shorter growing period. This applies equally to the Rongai area, where not only is rainfall uncertain, but head smut is on the increase. Two big factors in the growing of maize are time of planting and the obtaining of a level and even stand of plants. There appears to be an optimum time of planting, some two to three weeks after the commencement of the rains proper, in April, before or after which yields are affected; in addition, the crop is taken off earlier and ploughing may be done in November, when there is moisture in the soil. Late planted maize is always liable to be attacked by cut worm, and an uneven and ragged stand of plants results; two or even three replantings may be necessary, each planting being later and later, with increased chances of a diminished yield occurring. It would appear advisable to increase the number of planters and implements or decrease acreages. If a proper stand of plants is obtained on a smaller acreage, the same number of bags will be obtained as off the larger acreage, owing to the larger yield per acre being obtained from a level stand. It is noticeable that while early planted maize gives fair or good yields, the later planted crop gives indifferent yields, and ploughing for the next season's crop is done late. Much may be done to obtain a level and even stand by the efficient grading of seed; the seed planted at present is of varying sizes, and it is impossible for the planter to drop seeds regularly.

Diseases and Pests.

Head Smut is increasing in the district; reports of infections as high as 70 per cent have been received from near Rongai. The disease is general in the Pipe Line, Rongai, Lower Molo areas, and to a less degree in the Solai, Olpunyata, Njoro and Nakuru areas. Small infections were noticed in

Subukia. Inspections of this disease were frequently made both by myself and in company with the Mycologist. Many farmers have adopted the method of cutting out and burning infected plants, while others have neglected to do even this. Some concerted action is necessary.

Ear Rot is general throughout the district, a 20 per cent infection being noted. Pinking has also been observed.

Stalk Borer.—Little of this pest has been observed in the main crop, but volunteer and late planted maize have been infected.

Corn Ear Worm was general throughout the district. It was especially noticeable at the time of tasselling and immediately before. A further infection took place when the cobs had formed and were still green; most damage was done to the badly covered and loose husked cobs. Specimens were forwarded to the Senior Entomologist for his identification. The same pest caused damage to field peas, eating the green peas from out of the pod.

Cut Worm caused considerable damage to late planted maize. A predaceous larva was found feeding on cut worms, and was identified as the larva of the Tiger Beetle, *Cicindlidæ*.

White Blight was observed; infections were small.

Wheat.

Good yields have been reported from all parts of the district, as much as 14 bags per acre being recorded; 7 to 8 bags appears to be a fair average. Lower yields and partial failures have also been reported, probably due to late planting. Where wheat has been planted early in May, the crop has done well, good yields being reported. Glume Blotch and Rust affected the crop.

A report of aphids causing damage to young wheat and barley was received.

Loose smut of wheat was observed in Subukia.

Barley.

This crop did well on the better soils, but smut was general. Yields as high as twenty bags were recorded.

Small acreages of beans, peas and njahi did well, the latter selling freely locally at Sh. 24 per bag on the farm.

Buckwheat produced an average of five bags per acre; the crop in most cases was allowed to volunteer, bearing a further three bags.

Small plots of Soya beans were observed to be growing well on a farm west of Menengai; rainfall was good and the soil had been inoculated. A black-seeded variety imported from South Africa showed exceptional growth. Nodule development was good. At Subukia the crop was fair, but at Rongai it showed poor growth and nodule development.

Mexican marigold is steadily increasing in the lower altitudes of the district.

Leucas is proving a troublesome weed in pasture. A collection of grasses has been forwarded to the Mycologist and to the Royal Botanic Gardens, Kew, for identification.

I take this opportunity of expressing my thanks to J. J. Toogood, Esq., J. E. W. Whitmore, Esq., R. Edmondson, Esq., and H. McEvoy, Esq., on whose farms experimental plots were situated, for the valuable assistance rendered to me at all times; to the Provincial Commissioner of the District, and to the Plant Breeder.

H. J. TAYLOR,
Assistant Agricultural Officer.

was to find what effect applications of superphosphate, Seychelles guano, boma manure and green manure had on the typical red soils of the district.

Plot A.—Control—maize with no treatment.

Plot B.—Green manure (njahi beans).

Plot C.—Maize, plus 100 lb. superphosphate per acre.

Plot D.—Maize, plus 70 lb. Seychelles guano per acre.

Plot E.—Maize, plus 12 tons boma manure per acre.

The following are the results :—

					Sum of rows in lb.
74 D	126 E	B	62 C	43 A	305
79 C	B	71 D	24 A	151 E	325
52 A	104 D	100 C	197 E	B	453
B	53 A	202 E	93 D	111 C	459
138 E	70 C	34 A	B	90 D	332
Sum of columns in lb. 343 353 407 376 395					=1,874
Mean of rows and columns					=374.8
					Mean
Control	=A =	34 + 53 + 52 + 24 + 43 =	206	41.2	
Super	=C =	70 + 111 + 100 + 79 + 62 =	422	84.4	
Guano	=D =	90 + 93 + 104 + 71 + 74 =	432	86.4	
Boma Manure	=E =	138 + 202 + 197 + 151 + 126 =	814	162.8	
					1,874

General mean = 93.7

Analysis of Variance.

Variance due to	Degrees of freedom	Sum of squares	Variance	Standard deviation
Rows	4	5,597.2	1,399.3	
Columns ..	4	733.2	183.3	
Treatments ..	3	38,354.2	12,784.7	
Remainder ..	8	1,537.6	192.2	13.86
Total ..	19	46,222.2	2,432.7	

Standard deviation of a single plot : 13.86 lb.

Standard error of mean of 20 plots : 6.2 lb. = 0.62 bags per acre.

Summary of Results.

Average yield	Control	Super	Guano	Boma manure	Mean	Standard error
In bags per acre	4.12	8.44	8.64	16.28	9.37	0.62
In per cent. . . .	43.97	90.07	92.21	173.75	100	6.62

Taking three times the standard error as significant, it will be seen that there is a very significant difference between all the treatments except between superphosphate and Seychelles guano. This shows that there is a great deficiency in phosphates and organic matter in the soil.

The njahi beans planted in the B plots did not yield sufficient green material to be ploughed in to expect a true estimate of the advantage of a maize crop following a green manure crop. This soil appears to have got so far out of condition that a leguminous crop will not thrive, and in this case the limiting factors seem to be phosphates.

2. *Green Manure and Liming Experiment.*—The objects of this experiment were to test the effect on the succeeding crop of maize of a leguminous against a non-leguminous green manure crop and the effect of lime applied at the rate of half a ton per acre.

All plots 1–20th acre each	43 A	B	68 A	C	76 A	A =maize with no treatment B =cowpeas C =buckwheat with no treatment D =maize with lime E =cowpeas with lime F =buckwheat with lime
	49 D	E	63 D	F	115 D	

Again the green manure plots were very disappointing. The yields of the limed and control maize plots were :—

Limed	Control
1. 49 lb.	1. 43 lb.
2. 63 lb.	2. 68 lb.
3. 115 lb.	3. 76 lb.
227 lb.	187 lb.
Mean 75.66 lb.	Mean 62.33 lb.
= 7.566 bags per acre.	= 6.233 bags per acre.

As the standard error of the difference is 1.83 bags, there is no significant difference between the two yields.

3. *Trial Crops.*—(a) *Grain Crops.*—Wheat, barley and beans were tried without fertiliser, but the growth was so poor that no yields were taken. These trials will be continued next season with a dressing of 100 lb. superphosphate.

(b) *Green Manure Crops.*—Small plots of groundnuts, indigenous lupins, sunflowers, *crotolaria intermedia*, niger oil, sweet clover and rape were tried without fertiliser. All were disappointing, again showing that, to grow green manure crops on this, a fertiliser must be used.

Plot No. 2.—Barnes Brothers, Hoey's Bridge.

1. *Manurial Experiment.*—Layout as in Plot No. 1.

152 C	146 A	165.5 D	B	172 E	A = maize with no treatment.
142.5 E	B	163.5 A	156.5 C	138 D	B = green manure (Njahi beans).
64.5 A	91 D	B	156 E	146 C	C = maize + 100 lb. superphosphate per acre.
B	61.5 E	88.5 C	85 D	117 A	D = maize + 70 lb. Seychelles guano per acre.
103.5 D	87 C	96.5 E	82 A	B	E = maize + 12 tons boma manure per acre.

Analysis of Variance.

Variance due to	Degrees of freedom	Sum of squares	Variance	Standard deviation
Rows	4	16,967.4	4,241.9	
Columns ..	4	4,749.9	1,187.5	
Treatments ..	3	535.5	178.5	
Remainder ..	8	3,164.9	395.6	19.9
Total	19	25,417.7	1,337.7	

Standard Error=8.9 lb. = 0.89 bags per acre.

Summary of Results.

Average yield per acre	Control	Guano	Boma Manure	Super	Mean	Standard error
In bags per acre	11.46	11.66	12.57	12.6	12.07	0.89
In per cent. . .	95.77	96.6	104.14	104.4	100	7.37

There is no significant difference between any of the treatments. As the njahi beans on the B plots yielded a large amount of green material to be ploughed in, this experiment will be continued next year, with slight alterations.

2. *Green Manure and Liming Experiment.*—Similar to Experiment No. 2 on Plot No. 1. No results will be obtained until next season.

3. *Crop Trials.*—(a) *Green Manure Crops.*—Niger oil, indigenous lupins, crotolaria intermedia, and an indigenous crotolaria, were tried. All were disappointing, except the indigenous crotolaria, which completely covered the ground and gave a fair amount of foliage to be ploughed in.

(b) *Soya Beans.*—A small sample of Soya beans, with inoculated soil, was received from the Scott Agricultural Laboratories. It is too early yet to give an opinion on the suitability of this crop for this district.

Plot No. 3.—C. Kirkman, Esq., Sergoit.

Manurial Experiment.

30 C	A	26 B	30 E	21 D	A = green manure (Njahi beans).
33 E	24 D	A	30 B	25 C	B = wheat + 70 lb. Seychelles guano per acre.
A	18 C	25 E	15 D	23 B	C = wheat + $\frac{1}{2}$ ton lime per acre.
14 D	21 B	16 C	A	18 E	D = wheat (control).
20 B	23 E	15 D	15 C	A	E = wheat + 400 lb. boma manure dust per acre.

Analysis of Variance.

Variance due to	Degrees of freedom	Sum of squares	Variance	Standard deviation
Rows	4	392.8	98.2	
Columns ..	4	31.3	7.83	
Treatments ..	3	187.4	62.46	
Remainder ..	8	26.3	3.29	1.8
Total	19	637.8	33.57	

Standard error = 0.8 lb. = 0.08 bags per acre.

Summary of Results.

Average yield	Control	Lime	Guano	Boma manure dust	Mean	Stand'd. error
In bags per acre	1.78	2.08	2.4	2.58	2.21	0.08
In per cent. ..	80.5	94.1	108.6	116.7	100	3.62

There is a significant difference between all the treatments, but here again the green manure plots were a complete failure.

The cost of the fertilisers used in these experiments, i.e. the cost at Eldoret, was at the time of application :—

	Rate of application
Superphosphate .. Sh. 150 per ton ..	100 lb. per acre.
Seychelles Guano Sh. 150 per ton ..	70 lb. per acre.
Lime Sh. 38 per ton ..	$\frac{1}{2}$ ton per acre.

GENERAL.

1929 has been a good year for most farmers in both the Uasin Gishu and Trans Nzoia Districts. The rains, although late in coming, have been evenly distributed throughout the growing period. The maize and wheat crops have yielded higher than was expected, and yields of 30 bags of maize and 16 bags of wheat per acre have been reported.

The chief difficulties that farmers have to contend with are: Soil erosion, loss of fertility due to the loss of organic matter in the soil, poor yields due to bad stands, weeds and pests, and seed deterioration. Lectures on these subjects have been given to most farmers' associations, and notes on these lectures have been published.

Most farmers are now taking a keen interest in methods of maintaining soil fertility, particularly by trying to stop soil erosion and by the application of suitable fertilisers. My experiments have shown that the application of boma manure results in increased yields, and this is not only due to the humus and plant food materials supplied, but also to the fact that one is putting life into the soil—an important factor in these soils.

At the present stage of farming in this district, one realises that the farmer has not sufficient boma manure to manure all his land, but a great deal can be done to increase the humus content of the soil by including a green manure crop in his rotation. Small quantities of green manure crops were given out to farmers to try, and the most successful seem to be njahi beans, cowpeas, sunflowers, and indigenous crotolaria, but these trials will be continued next season.

After one season's work, I can recommennd to all farmers in this area the application of phosphates and organic matter in the form of boma manure or the ploughing in of a green crop.

MAIZE LEAF BLIGHT.

This fungus disease of maize is increasing in this province, and has been the cause of poor yields on many farms.

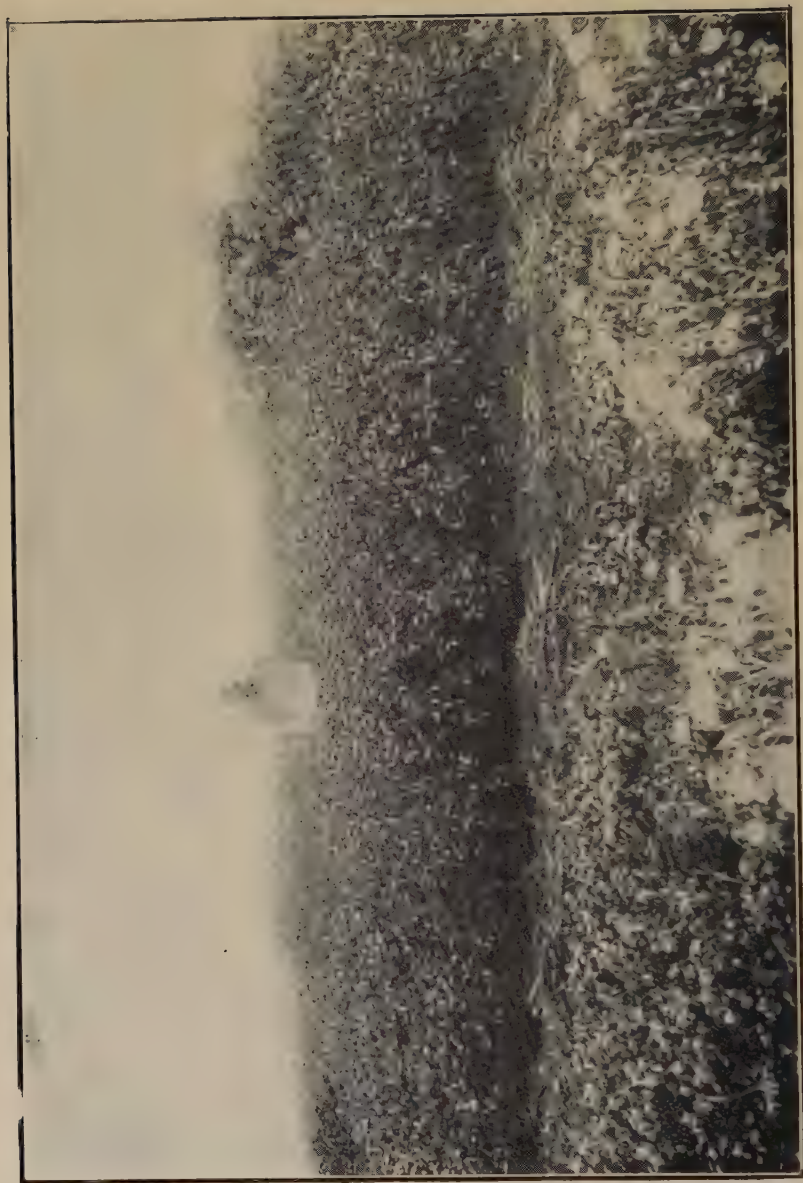
Ear-to-row tests were carried out on Sabwani Estate, Kitale, and on Elgon Downs Estate, Kitale, with seed from plants selected last year as resistant and susceptible by the Plant Breeding Station. The results were very encouraging—

the rows from the resistant plants showing very little disease, whilst the rows from the susceptible plants were all badly infected.

Lectures and demonstrations on the field selection of maize plants were given at several centres, and the importance of selecting against leaf blight was duly stressed.

In conclusion, I should like to put on record my appreciation of the valuable assistance given to me by the farmers who have co-operated with me in experimental work, and many others who have helped me in other ways.

P. BOOTH,
Agricultural Officer.



NIGER OIL—SCOTT AGRICULTURAL LABORATORIES

APPENDIX O.

SCOTT AGRICULTURAL LABORATORIES.
ANNUAL REPORT FOR 1929.

STAFF.

Mr. Lyne Watt proceeded on leave on the 18th January leaving Mr. Gillett in charge. On the 24th June, the writer returned from leave and was posted in charge.

Mr. Maher and Mr. Ransford arrived here on first appointment on the 8th November. Mr. Maher was posted to Njoro on the 24th November, and Mr. Ransford proceeded to Eldoret on the 25th November, returning from there on the 10th December.

Mr. Gaddum arrived here on first appointment on the 23rd December.

RAINFALL.

The total rainfall was 41.28 inches, or 7.03 inches over average. This excessive rain practically all fell from July on. The long rains were late in breaking, as they did not commence properly until the 24th April.

Unusually heavy rains fell in July, August and September, causing a certain amount of damage to the various crops being harvested at that time.

TRAVELLING.

979 miles were travelled by motor car, and 53 days were spent away from the station on duty.

CORRESPONDENCE.

Inward letters, 512; outward letters, 598. The majority of the outward letters were of an advisory nature.

FIELD TRIALS AND EXPERIMENTS.

KENYA HYBRID FLAT WHITE MAIZE.

Further selection was carried out on this crop, which produced a good yield this year. Unfortunately, harvesting had to be done in the short rains, and in the absence of cribs much of the grain was lost.

MURATHA MAIZE.

It was noted this year that the crop was not breeding true, and was inclined to separate out into different varieties, the best but slowest in maturing being akin to Flat White.

The object, however, is to produce an early maturing maize, thus only those plants showing this characteristic were selected for further work.

A number of bags has been issued to farmers requiring a maize crop which will mature in 130 to 150 days.

It has been noticed that, as a general rule, maize planted much after the beginning of April gives a relatively poor yield.

GREEN MANURE TRIALS.

The fifth series of trials of twenty-six selected varieties were planted out, and yields, both green and sundried, were taken, the results of which are shown in Appendix I.

At this elevation the most promising are Cowpeas, Njahi, *Crotolaria incana*, Koinyange lupin, Wedge pea, New Zealand grass peas, and Niger oil.

A number of cowpea varieties was planted out for bulk-ing in the short rains, and they have made excellent growth.

A point for farmers to keep in mind when purchasing cowpea seed is that it must be fresh. If over a year old, a poor stand only is obtained.

FORAGE GRASS TRIALS.

These thirty grass plots continue to attract much attention from pastoralists and visitors interested in botany. Owing to the lateness of both rains this year, only one cutting has been made, weighings of which are shown in Appendix II.

The finest hay grass tried so far is *Panicum coloratum*. It gives a good yield, and is also relished by stock.

Of the grazing grasses, *Paspalum dilatatum*, Kikuyu grass, Naivasha Star, Toowomba, are all excellent.

The capacity of *Paspalum dilatatum* for holding its own and even smothering out weeds is especially noteworthy.

GRASS ESTABLISHMENT IN CATTLE BOMA.

In November, 1927, fifteen varieties of grasses were planted. Out of these the most successful are Kikuyu grass, Naivasha Star grass, and Kikuyu grass mixed with Kenya White clover, the latter providing the best pasture and being most readily grazed by cattle.

Of the remainder, *Paspalum dilatatum* has held its own, and is well grazed. *Panicum maximum*, though patchy, when kept short and succulent by grazing, is a favourite with stock. Most of the other grasses have been smothered out or else are more or less unpalatable.



SPROUTING POTATOES AS A HOST FOR MEALY BUG IN THE INSECTARIES—SCOTT AGRICULTURAL LABORATORIES

POTATOES—VARIETY TRIALS AND BULKING.

Trials were continued with six of the ten varieties imported early in 1927, using Arran Victory as the control. The remaining four varieties were bulked.

The whole crop was attacked by various forms of virus disease, the most tolerant varieties being Kerr's Pink, Great Scot, and Arran Victory. These, incidentally, gave the best yields.

The following were the yields :—

Arran Victory (Control) ...	8,671 lb. per acre.
Kerr's Pink	9,959 „ „
Great Scot	9,430 „ „
Abundance	8,832 „ „
Majestic	6,256 „ „
Golden Wonder	5,175 „ „

In the short rains, Kerr's Pink, Great Scot and Arran Victory were planted for bulking, and the part of the plot which had been badly washed was dressed with boma manure at the rate of 7 tons per acre. The luxuriant growth produced on this part of the land, as compared with the originally better section, is very marked.

Fresh seed is being imported in 1930, as it has been found that at this elevation seed tends to deteriorate after three years or six growing seasons.

COFFEE.

The work done in this section was performed under the guidance of the Senior Coffee Officer, and will be reported on by him.

WILD SILK PLANTATION.

The caterpillars were all parasitised last year, but are now recovering. From experience gained here the production of silk on a plantation scale would be unprofitable, but it is considered that natives should be encouraged to produce it round their villages.

YERBA MATE (*Ilex paraguensis*).

The rainfall here is too low for these trees to make the rapid growth which takes place in South America. The trees are, however, healthy, and are now $9\frac{1}{2}$ feet high at 4 years 9 months from seed.

A number of seed samples has been sent to farmers at the higher elevations.

SORGHUMS.

An experiment was laid down with rows of ten American varieties, using the Kikuyu White as a control between each row of exotic sorghum. The result is disappointing, as all the imported varieties have been completely killed off by rust and other fungus diseases. The indigenous varieties are also rusted, but in spite of this have made a fair crop. A number of the heads have been killed by smut, and a large percentage are attacked by a cerebella fungus.

A demonstration of the value of sorghum as a silage crop was laid down in the native shamba, which produced a very heavy crop, and was ready to harvest in six months.

In view of the excellent feeding value of this crop, it is considered worth while to carry out selective work against fungoid diseases.

SOYA BEANS VARIETY TRIALS.

At the beginning of the year, the legume bacterial culture of soya bean, kindly supplied by the Bureau of Agriculture, Washington, D.C., U.S.A., arrived, and inoculated seed was immediately planted under shade. Owing to the seed being old, germination was poor, but nitrogenous nodules were soon observed on the roots. At the beginning of the long rains fifteen different varieties of inoculated seed were planted on Plot 7. Varieties tried out were :—

Dixie	Uganda Columbia
Glycine Soya Benth.	S. Rhodesia—Green
Virginia	S. Rhodesia—Chocolate
Chiquita	Mammoth Yellow
Uganda Black	Tarheel Black
Laredo	Ito San
Uganda Yellow	Biloxi
Wilson's Early	

Nodules were formed on the roots of all varieties, but germination and growth were very disappointing. Only four varieties produced seed. These were :—

Dixie	Chiquita
Mammoth Yellow	Tarheel Black

This same shamba was again planted up at the beginning of the short rains, with the following varieties :—

Dixie	Haberlandt
Morse	Dunfield
Laredo	Mammoth yellow
George Washington	Hong Kong
Peking	Hahto
Chiquita	Lexington
Tokio	Habaro



KUDZU VINES—SCOTT AGRICULTURAL LABORATORIES.

One half of the shamba received lime (three tons per acre) and Seychelles guano (300 lb. per acre), while the other half received a dressing of Seychelles guano alone (300 lb. per acre).

The seed of all varieties planted was new and germination good. Nodules were found on the roots six weeks from planting, and growth was better than that obtained in the long rains, but, as yet, by no means good. An interesting point to note is that there is a definite difference in growth on the half of the shamba which received lime and Seychelles guano as compared with that portion which received Seychelles guano alone. The growing of soya beans on this plot will be continued.

LUCERNE VARIETY TRIALS.

Ten varieties were sown in April, 1928, and since the plants became one year old, four cuttings have been taken, which gave the following yields (the crop has had no irrigation):—

1. Dakota No. 12	..	5,590 lb. per acre
2. Dakota Common	..	8,360 "
3. Cape Provence	..	9,340 "
4. Utah 	..	7,780 "
5. Ladak	..	3,380 "
6. Ladak F. C. ..	..	4,000 "
7. Hunter River ..	..	10,160 "
8. Kansas Common	..	8,090 "
9. Hairy Peruvian	..	10,390 "
10 Grimm ..	..	5,810 "

From the above it will be seen that there is little to choose between Hairy Peruvian and Hunter River, Cape Provence being third best.

PERMANENT ROTATION TRIALS.

Thirty-two 1/10th of an acre plots were laid down in April, 1928, each one running a different rotation, two-course and four-course. Half of each plot was dressed with lime at the rate of one ton per acre.

Weighings have been taken each season, but as the trials have been in progress for such a short period it is thought that to give figures would be of little value.

WHEAT.

The Plant Breeder's new wheat, B. 286, was sown exclusively in the long rains, and made a very fine crop. Some damage was done during harvest by the heavy rains experienced in August. Yields were $10\frac{1}{2}$ bags per acre.

A number of the Plant Breeder's pure line wheats were sown in the short rains for bulking, and received a dressing of 150 lb. of superphosphate per acre. A small latin square has been laid down so that the yields of B. 286 and B. 286 C. may be compared.

RYE.

A good crop of rye was grown, giving a yield of ten bags per acre. There was no ergot present.

PYRETHRUM.

A quarter of an acre of seedlings was planted out in the short rains, and they are making satisfactory growth.

KUDZU VINE.

Seedlings were planted out in April, and though extremely slow in starting, have now completely covered the ground, and should prove an excellent forage crop for this country.

MISCELLANEOUS CROPS.

One-hundred-and-one crops were grown for observation and bulking, comprising varieties of *Crotolarias*, Russian oats, Russian peas, barley, *Lathyrus*, *Ervum lens*, Cow peas and Lupins. The more promising varieties will be given further trial before accurate observations can be made.

Russian oats and peas made very luxuriant growth at first, but later went down with rust and mildew.

EDIBLE CANNA.

Planted out in November, 1927. Much interest has been taken in this crop and roots were divided up and issued for trial to farmers in various parts of the country.

Starch, or the "Queensland arrowroot" of commerce, was extracted, giving 13.21 per cent.

FRUIT TREES.

A number of Pecan nut seeds were planted, giving a 20 per cent germination.

The trees received from America have done well, and were planted out in the chicken runs in November.

SUGAR QUARANTINE.

Eight varieties were planted out under the supervision of the Mycologist, who will report on them.

MANURIAL EXPERIMENT.

Two further latin squares were laid down, one qualitative with phosphatic manures and the other quantitative with super-phosphate. In addition, the residual effect of Seychelles guano from last year's experiment was observed.



COMPOST PITS FOR AEROBIC TREATMENT—SCOTT AGRICULTURAL LABORATORIES

These experiments were under the control of the Assistant Agricultural Chemist, and will be reported on by him.

COMPOST PITS.

Three experimental pits were opened in October, and filled with the following :—

1. 2 tons straw.
3 cwt. Adco (Standard).
2. 9,710 lb. grass.
247 lb. Vitic Adco.
3. 2 tons straw.
150 lb. Sulphate of ammonia.
300 lb. lime.
150 lb. super-phosphate.

LOCUSTS.

Swarms of locusts visited the station in February and May, but were driven off before any damage was done.

CONSTRUCTIONAL.

During the year the insectaries, a coffee factory and the apprentices' quarters were built.

A new cage for the Plant Breeder was erected.

POULTRY.

Considering the small amount of European supervision it has been possible to give, the year under review must be considered as one of success, and credit is due to the native instructor in charge.

Approximately 900 chicks were hatched out during the year, and of these three hundred were issued to the Native Reserves, while another 350 remain to be issued early in 1930.

Apart from the value of this section as a source for the supply of poultry, its value from an educational standpoint has become very apparent. Several parties of natives from schools and missions have visited the runs during the year, while odd natives are frequently asking to be shown round.

AGRICULTURAL SHOWS.

A representative departmental exhibit was staged at Nakuru in December. A large section, showing samples of green manures and their respective yields of green and dry matter, attracted much attention from visitors.

WEEDS.

These have caused little trouble.

WORK OXEN.

There are seventeen, all of which remained healthy during the year.

SEED ISSUES.

The following issues were made to settled areas :—

					<i>Samples.</i>
Seeds	...	...	...	...	283
Soya Beans	...	...	...	...	38
Cuttings	...	...	...	...	15
Roots (other than cuttings)	...	...	...	...	30
Grasses	...	...	...	...	44

In bulk—

7 bags of maize,
38 bags of potatoes, and
9 bags of buckwheat.

These samples are issued to farmers, with the object of obtaining useful information as to the behaviour of crops under varying conditions. A system has been in operation since October whereby forms asking for detailed information are enclosed with the samples supplied. On completion of the trials the forms are filled up by the farmer and returned to this station. In this way results from all over the country are easily correlated, and much useful data will be accumulated for future guidance.

Thanks are due to the many planters who have gone to much trouble in making reports on their trials.

GENERAL.

Large numbers of settlers and others interested in farming have visited the station during the year, most of whom have expressed their appreciation of the work being done.

Members of the British Association visited the Laboratories in August.

Relations with scientific officers have been excellent, and they have helped with the work in every way possible.

W. G. LECKIE,
Agricultural Officer.



POULTRY RUNS—SCOTT AGRICULTURAL LABORATORIES, NAIROBI

APPENDIX NO. I
GREEN MANURE TRIALS.

No.	Botanical Name	Common Name	Seed per acre	Days in ground	Weight per acre cut above the ground	Weight per acre Sundried	Remarks
1	<i>Vigna sp.</i>	Cowpeas—Whippoorwill	lb. 35	106	lb. 8,760	lb. 1,680	
2	<i>Vigna sp.</i>	Cowpeas—Kilimanjaro...	20	106	9,960	2,320	
3	<i>Vigna sp.</i>	Cowpeas—Bura...	20	106	10,480	2,480	Fine growth.
4	<i>Vigna sp.</i>	Tepary Bean	..	..	..	..	
5	<i>Phaseolus lunatus</i>	Lima Bean—Abundance	60	106	9,200	2,800	
6	<i>Phaseolus lunatus</i>	Lima Bean—Salmon	60	106	5,840	1,600	Washed.
7	<i>Phaseolus lunatus</i>	Lima Bean—Cream	15	66	3,440	860	Washed.
8	<i>Phaseolus lunatus</i>	Lima Bean—Black	50	106	8,480	2,240	
9	<i>Phaseolus multiflorus</i>	Scarlet Runner	80	66	3,840	960	
10	<i>Phaseolus lunatus</i>	Dutch Runner	80	66	5,480	1,390	

APPENDIX I.—(Contd.).

No.	Botanical Name	Common Name	Seed per Acres	Days in Ground	Weight per acre cut above the ground	Weight per acre ground	Remarks
11	<i>Phaseolus lunatus</i>	Spotted Madagascar	lbs. 80	106	lbs. 11,600	lbs. 3,320	Heavy luxuriant growth.
12	<i>Crotalaria intermedia</i>	.. ..	7	106	9,750	2,880	
13	<i>Crotalaria incana</i>	.. ..	7	106	21,000	5,600	Quickly rotted and best of <i>Crotalaria</i> s tried.
14	<i>Dolichos lablab</i>	Black Njahi	45	106	11,240	3,800	One of the best green manures tried.
15	<i>Dolichos lablab</i>	Brown Njahi	40	106	8,320	2,720	
16	<i>Dolichos lablab</i>	Njahi Red	40	106	14,800	5,200	Very fine luxuriant growth.
17	.. ..	Velvet Bean—Stringless	80	106	4,720	1,200	
18	<i>Brassica campestris</i>	Rape	..	..	..	..	Failure.
19	<i>Guizotia abyssinica</i>	Niger Oil	6½	66	3,000	..	On poor washed land.
20	<i>Fagopyrum esculentum</i>	Buckwheat—Polish	20	66	1,960	490	Very poor growth.
21	<i>Fagopyrum esculentum</i>	Buckwheat—American	30	66	7,120	1,960	

APPENDIX I.—(Contd.),

No.	Botanical Name	Common Name	Seed per Acre	Days in Ground	Weight per acre above the ground	Weight per acre ground	Remarks
22	<i>Phaseolus vulgaris</i> ..	Beans, Canadian Wonder	lbs. 40	66	lbs. 7,040	lbs. 1,900	Not recommended.
23	<i>Pisum sativum</i> ..	Field peas ..	37	66	4,400	1,500	Makes good green manure with sunflower.
24	<i>Lathyrus</i> ..	New Zealand Grass Pea	25	106	2,680	720	Poor growth, some wash.
25	<i>Lathyrus</i> ..	Wedge Pea ..	25	106	6,760	1,840	Some wash.
26	<i>Lupinus</i> sp. ..	Lupin purple white ..	35	106	1,440	360	Badly washed.
27	<i>Lupinus</i> sp. ..	Lupin—Koinyange ..	20	106	9,000	1,840	A quarter of plot badly washed.
28	<i>Lupinus</i> sp. ..	Lupin White ..	63	106	9,000	1,840	Best of lupins.
29	<i>Lupinus</i> sp. ..	Lupin blue pinnate ..	26	106	6,640	1,720	
30	<i>Lupinus</i> sp. ..	Lupin blue ovate ..	63	106	9,880	2,200	

Nine varieties of green manures from the United States of America and Federated Malay States were tried and found failures.

APPENDIX NO. II.
GRASS PLOTS YIELDS.

No	Botanical Name	Common Name	Yield per acre (Tons)	Remarks
1	<i>Melinis minutiflorus</i>	Molasses Grass ..	12.5	Not much relished by stock.
2	<i>Pennisetum ciliare</i> ..	.. ..	9.4	Coarse grower.
3	<i>Cymbopogon afronardus</i>	Buffalo Grass ..	18.0	Very coarse, but young shoots are relished.
4	<i>Themeda triandra</i> ..	Oat Grass ..	7.1	Good grazing when newly cut.
5	<i>Sorghum rigiaifolium</i>	.. ..	14.7	Coarse.
6	<i>Hyparrhenia rufa</i> ..	Horse Grass ..	8.4	Coarse.
7	<i>Brachiaria soluta</i> ..	.. ..	4.9	Makes poor straggling growth.
8	<i>Setaria aurea</i> ..	Golden Timothy ..	10.2	Makes fair hay.
9	<i>Brachiaria brizantha</i>	.. ..	11.1	Coarse hay, good grazing.
10	<i>Panicum maximum</i> ..	Guinea Grass ..	7.1	Much relished when kept down by grazing.
11	<i>Paspalum scrobiculatum</i>	.. ..	8.0	Poor straggling growth.
12	<i>Panicum tri holcladum</i>	.. ..	12.9	Coarse hay, but provides good grazing when young.
13	<i>Paspalum dilatatum</i>	.. ..	5.3	Fine pasture grass.
14	<i>Panicum meyerianum</i>	.. ..	12.5	Good drought resister.
15	<i>Panicum coloratum</i> ..	.. ..	13.8	Best hay tried, best drought resister.
16	<i>Pennisetum riparium</i>	.. ..	..	Poor growth.
17	<i>Leptochloa obtusiflora</i>	.. ..	5.4	Poor growth.
18	<i>Cynodon dactylon</i> ..	Naivasha Star Grass	7.1	Good pasture grass in the drier parts of the country.
19	<i>Amphilophis pertusa</i>..	.. ..	9.8	Fair hay.
20	<i>Chloris gayana</i> ..	Rhodes Grass ..	21.0	Heaviest yielder, makes good hay.
21	<i>Echinochloa stagnina</i>	.. ..	6.2	Fairly good grazing and hay crop.

APPENDIX II.—(Cont.).

No.	Botanical name	Common name	Yield per acre (Tons)	Remarks
22	<i>Setaria plicatilis</i> ..	.. ..	9.8	Relished when grazed.
23	<i>Echinochloa pyramidalis</i> ..	.. ..	6.7	Very coarse.
24	<i>Pennisetum clandestinum</i> ..	Kikuyu Grass ..	..	Good grazing.
25	<i>Paspalum notatum</i> ..	.. ..	..	Not as good a pasture as <i>dilatatum</i> , makes a good close turf.
26	.. ..	Towoomba, Canary Grass ..	..	Fine succulent grazing grass, does not have spreading habit.
27	<i>Eragrostis paniciformis</i> ..	.. ..	3.5	Poor hay, good when grazed.
28	<i>Cynodon dactylon</i> ..	Naivasha Star ..	}	<i>Cynodon dactylon</i> has practically crowded out the clover and <i>Pennisetum clandestinum</i> .
	<i>Trifolium johnstonii</i> ..	Kenya White Clover ..		
	<i>Pennisetum clandestinum</i> ..	Kikuyu Grass ..	6.2	Makes strong growth and the shoots are relished by stock
29	<i>Sporobolus filipes</i> ..	.. ..	7.1	when young

APPENDIX P.

ANNUAL REPORT OF THE AGRICULTURAL
OFFICER, SOUTH KIKUYU RESERVE.

STAFF

The work was under my control from June until the end of the year.

Native agricultural instructors, 10; Local Native Council labourers, 9.

TRAVELLING.

2,538 miles were travelled by motor car, and 53 days were spent in the Reserve.

RAINFALL.

The elevation of this Reserve ranges between 5,000 and 8,000 feet, and its rainfall therefore varies a great deal. In most parts the long rains were late in breaking, causing much anxiety to the natives lest it should mean a further shortage of food. This, however, was alleviated with the commencement of the rains in April, and when still more fell in July crops made rapid growth.

The short rains broke between the middle and end of October, and have been above average.

NATIVE AGRICULTURAL SCHOOL AT SCOTT
LABORATORIES.

In residence at the end of the year :—

Wakikuyu	...	...	...	...	37
Embu	...	...	...	...	6
Wakamba	...	...	...	...	4
Kamasia	...	...	...	...	1

The work of these apprentices continues to be very satisfactory, both at school and in the shamba.

The number of applicants for the three-years' course is far in excess of vacancies, making it possible to select only the more desirable. This year, for example, there were sixty applications for twenty vacancies. Most of these are Wakikuyu, but boys from Meru and Kamasia are now becoming available.

Twenty-four apprentices were passed out during the year, of whom—

- 14 became instructors,
- 6 returned to their Reserves and are working their shambas.
- 2 went to the Forestry Department,
- 1 became a teacher,
- 1 went to the Alliance High School.

Three boys passed the Elementary B School Certificate in July, and five more sat for the Elementary C Certificate in December.

Each apprentice has a school garden, which he runs entirely on his own, and for which marks are awarded each season.

SOUTH KIKUYU RESERVE CROPS.

Wattle.

This industry is now being developed on an increasing scale, and there are still large areas of land at the higher elevations which might well be utilised for the growing of these trees.

A survey has been commenced with the object of ascertaining the age and acreage of plantations, which will enable wattle extract companies to make arrangements in advance.

From August to December, inclusive, 933 tons of native bark were delivered at the factory at Limuru, Sh. 54 per ton being paid for green bark.

There are large areas which cannot be served by the factory, and the methods used by native and Indian traders in handling this bark are most unsatisfactory. Strips of bark are cut into small pieces and are then spread on the ground to dry, with the result that if rain comes much of the tannic acid is washed out. Then the bark is swept up along with foreign matter, bagged and exported. The result is a secondary place on the home market.

Instruction has been given on growing wattle and on the stripping and marketing of the bark, and it is hoped that the use of improved methods will soon result in a product of creditable quality.

Maize.

The 1928-29 crop was poor, and by June natives were very short of food. The root crops, however, carried them over until the maize was harvested in September, which, with the exception of the Thika end of the district, comprising the locations of Wairima, Karanja and parts of Kibathe's, was an average crop.

As will be seen from Appendix I, quite a large quantity of maize and maize meal was put on rail at the various stations. In addition to this, some hundreds of tons have been consumed locally on farms, or sold and bartered to Akamba.

The short rains crop is promising.

Beans.

In many parts of the district the young plants were demolished by locusts, necessitating replanting. The resultant crop was poor, as it had set pods before the rains which came in July, and helped the later maturing crops so much.

Potatoes.

A good crop was obtained in the district at elevations over 6,000 feet, and this food is increasing in popularity, both for consumption and sale. It played a most important part this year in the support of natives when other food was unobtainable, many existing solely on this produce.

Efforts have been made to teach natives grading and proper planting methods, and it is now fairly common to see shambas with potatoes ridged up and spaced.

Peas.

Large quantities of this crop are grown at the higher elevations, and good crops have been obtained. Natives now realise its high food value.

A small local trade has been started, which is likely to increase as the importance of the crop as a green manure becomes more appreciated in settled areas.

Wheat.

Good yields have been obtained all over the district, and the crop is rapidly increasing in popularity as a food, and is taking the place of millets in the short rains.

Yams.

In the northern end of the district these have been completely destroyed by mealy-bug, and it is thought that the pest is slowly spreading south. The crop is to be encouraged as a famine food.

Sweet Potatoes.

Large areas are down to this root, the foliage being much in demand for the feeding of stock, while the roots are a favourite diet.

Mtama.

Although the areas under this crop are on the decrease, there is still a fair amount grown. Its main disadvantage is that it takes ten months to mature.

This year good crops will be obtained.

Millets.

Here again the area under these crops is diminishing, maize and wheat taking their place.

At the higher elevations of 6,500 feet and over, the cold weather has greatly diminished the yields, affecting the Ki-kuyu variety of fox-tail millet especially, reducing its yield by half.

Bengal Gram.

Numbers of natives are growing this crop with profit, as it finds a ready sale on the Indian market.

Lucerne.

The value of this forage crop is becoming better known throughout the Reserve, and in places natives are purchasing seed with the object of growing enough food near their houses for the feeding of milk cows.

INSECT PESTS.

Stalk Borer.

Much damage was done to the maize crop by this pest, and it was thought necessary to bring the matter before the Local Native Council. In August a resolution was passed that all maize stalks should be burned before further planting was commenced. This has since been carried out satisfactorily.

The mtama crop presents the chief difficulty in controlling the borer as, growing through both rains, it acts as a host until the maize crop is sufficiently grown.

Mealy-bug.

This pest has killed off all the yams in the Thika end of the district, and appears to be making its way south.

It has been found attacking pigeon peas, njahi, castor oil trees, and weeds such as Sodom apple and Blackjack (*Solanum incanum* and *Bidens pilosa*).

STOCK.

Cattle.

Though there has been no outbreak of disease, large numbers of cattle have died during the dry season through lack of fodder.

The numbers of grade animals are increasing, especially among those kept around the homesteads, because of their higher milk yields.

Goats.

These are on the increase, natives finding that they survive the dry seasons and consequent shortage of fodder better than other stock.

Sheep.

In the Uplands area, numbers of Romney Marsh grade are found which thrive as well as, and are larger than, native sheep.

HIDES AND SKINS.

Thirty-one demonstrations of shade drying were given in the Reserve during the year.

Owing to the drop in price of hides and skins, it is becoming increasingly difficult to get natives to take an interest in this work, and latterly hides for the purpose of demonstration have been almost unobtainable.

Thanks are due to the Old East Africa Trading Company who have given demonstrations at their sheds, and have encouraged natives by buying shade dried hides at above their market value.

POULTRY.

Natives are now very keen on improving their birds by the introduction of good males, and it is considered that the time has arrived when they should be asked to pay a few shillings per bird towards the cost of raising the stock.

Already one can see the improvement in the size of the chickens in the Reserve, due to the past issue of Rhode Island Red cocks.

During the year a number of native Rhode Island Red birds was inoculated against Kikuyu fowl disease.

GHEE.

Little is being done in making use of the surplus milk in Ndeiya, and the Athi Plains farms, where large numbers of cattle are grazed on the system of twenty head of cattle per one labourer supplied.

It is anticipated that next year the Local Native Council will vote funds for the erection of a ghee factory at Ndeiya.

EXPERIMENTAL AND SEED RAISING PLOTS.

As a rule, the land allowed by natives for these plots is the poorest which can be found. This is not without its advantage, since it makes it possible to demonstrate one of the most important principles of agriculture, namely, increase and conservation of fertility through the use of proper methods.

There are now seventeen plots in the district, each showing a suitable rotation of crops under different methods of planting.

Through the medium of these plots, experimental work is carried out, new crops are introduced, and varieties are tried out for the ultimate benefit of the native.

GENERAL.

Though agricultural progress is generally speaking slow, many instances of praiseworthy advancement are to be seen, such as holdings of six to ten acres fenced, ploughed, and the crops rotated. Other smaller gardens are very well kept, and supporting very much better crops than the neighbouring shambas, where improved methods are not adopted.

The most serious problem at present is soil erosion and loss of fertility, which is very general throughout the whole Reserve, and is giving cause for much anxiety for the future. Efforts to combat this are being made by urging natives to plant rows of sweet potatoes, strips of grass or hedges and trees at intervals across the slopes.

The Kikuyu Central Association has been giving less trouble lately, and members have even offered their services for the wattle survey.

Markets are well attended, and a very large trade has been done with Akamba.

The attached Appendix shows the quantities of native produce railed from the various stations in the District; these figures give proof of a normal and satisfactory situation. The following seed, etc., was issued:—

Maize	...	...	...	...	1,000 lb.
Beans	...	...	...	...	1,500 lb.
Peas	...	...	...	...	1,200 lb.
Potatoes	...	...	...	...	1,800 lb.
Wheat	...	...	...	...	2,100 lb.
Lucerne	...	...	...	...	20 lb.
Cockerels	...	...	...	...	81
Pullets	...	...	...	...	115

I should like to express my thanks to District Officers, who have given me every possible assistance in my work.

W. G. LECKIE,
Agricultural Officer.

APPENDIX I.

CROP EXPORTS FROM RESERVE BY RAIL, JANUARY TO NOVEMBER, 1929.

Station from	Wattle bark	Maize	Maize flour	Potatoes	Beans	Peas
	Tons	Tons	Tons	Tons	Tons	Tons
Ruiru	163	254	375	5	5	..
Thika	90	1,053	1,249	..	476	..
Kabete	12	60	16	14	2	1
Kikuyu	60	265	1,265	75	62	64
Limuru	1,243	19	262	2,343	1	3
Uplands	448	47	..	1,300	..	..
Escarpment ..	..	15	27	2,175	3	25
	2,886	1,713	3,194	5,912	549	93



GENERAL VIEW OF THE MAIZE CRIB FOR SEED-RAISING PLOTS AND
POULTRY RUNS—EMBU



KENYA GOVERNOR WHEAT IN THE EMBU SEED-RAISING PLOT,
BEING INSPECTED BY LOCAL CHIEFS.

APPENDIX Q.**ANNUAL REPORT OF THE ASSISTANT AGRICULTURAL OFFICER, EMBU AND SOUTH NYERI DISTRICTS, 1929.****STAFF.**

The following staff changes took place during the period under review :—

Mr. R. Finch was posted to the Fort Hall District, where he took over from me in April.

Major Parminter and Mr. Cottington, temporary locust officers, reported at Embu towards the end of February, and assisted with the work in connexion with seed distribution and famine relief. They returned to Nairobi in May.

As from the beginning of February and up to the end of August, my work, in accordance with instructions received from the Hon. Senior Commissioner, Nyeri, was confined exclusively to the Embu district.

Seven temporary locust officers reported during the month of December, and assisted with the work in connexion with the destruction of hoppers in the Lower Emburere Division.

Fourteen native agricultural instructors and twenty-eight casual labourers were employed in the Embu and South Nyeri districts.

Three agricultural apprentices arrived in the district in February, and assisted with seed distribution and famine relief work until the end of June, after which they were sent back to Nairobi to complete their studies at the Scott Agricultural Laboratories.

WEATHER AND RAINFALL.*Embu District.*

The 1928 short rains lasted until the end of January, 1929. Although in no great quantity, they proved sufficient for the crops.

The long rains were late in commencing, and it was feared that they were going to fail; these, however, finally broke on April 15th, nearly a month late, and ceased in June, when the weather became overcast and cold.

The short rains, 1929, commenced nearly a month ahead of the usual time, and continued right through with hardly a break up to the middle of December. From information

received these rains were the heaviest experienced in the district for a great number of years.

Record of Rainfall			1928 Inches	1929 Inches
January	..	..	2.15	2.64
February	..	..	..	..
March	..	..	1.89	2.82
April	..	..	8.99	7.02
May	..	..	10.27	3.50
June	..	..	.83	.34
July	..	..	.26	1.48
August	..	..	.32	.32
September	..	..	.20	2.36
October	..	..	.93	4.56
November	..	..	7.80	8.57
December	..	..	.86	6.03
Total			34.50	39.64

South Nyeri District.

The short rains were exceptionally heavy, and of unusual duration; they started early and continued until Christmas. 23.45 inches fell in the four months, September to December, while in the first eight months only 21.78 inches were recorded. The total for the year registered at the Boma, Nyeri—45.23 inches—was satisfactory. In the Karatina and Tumutumu areas the short rains were heavier than in Nyeri, and north of Karatina, near the forest line, extremely heavy, some 20 inches falling at the West Kenya Saw Mills in five weeks. Roads and communications suffered as a result of the exceptionally heavy rains.

Record of Rainfall			1928 Inches	1929 Inches
January	..	..	.85	1.07
February	..	..	.25	.53
March	..	..	1.41	1.68
April	..	..	16.35	6.26
May	..	..	13.60	5.85
June	..	..	2.36	2.16
July	..	..	.64	2.52
August	..	..	1.58	1.71
September	..	..	2.05	2.76
October	..	..	10.23	7.32
November	..	..	2.68	4.91
December	..	..	1.29	8.46
Total			53.29	45.23

Keruguya Sub-station (South Nyeri).

During the first half of the year, very heavy winds prevailed and during the last part of the year there was remarkably little sunshine. This station having been closed down as from June to October, rainfall records for that period are not available.

Record of Rainfall			1928 Inches	1929 Inches	
January	..	..	1.97	.76	
February	..	..	.34	.09	
March	..	..	3.30	3.58	
April	..	..	6.99	8.52	
May	..	..	9.97	4.89	
June	..	..	3.08	.52	(up to 7th)
July	..	..	.92	..	
August	..	..	.70	..	
September	..	..	.17	..	
October	..	..	6.61	7.07	(from 8th)
November	..	..	2.93	6.52	
December	..	..	1.56	5.39	
Total ..			38.54	37.34	

TRAVELLING.

A total of 6,925 miles was travelled by car on duty, and 193 nights spent on safari. The mileage was made up as follows :—

Embu District.

(a) Agricultural work	...	...	3,020
(b) Famine relief	...	...	780
(c) Locust work	...	...	1,300

Fort Hall District.

(a) Agricultural work	...	...	525
(b) Locust investigation	...	...	300

South Nyeri District.

(a) Agricultural work	...	...	800
(b) Locust work	...	...	200

INSTRUCTIONAL WORK.

In addition to the instructions given by the Native Agricultural Instructors stationed in the various districts, several barazas have been held, and whenever possible individual instruction has been given at villages in the various locations.

CROPS.

The 1928 short rain crops standing in the fields at the beginning of the year were, with the exception of one or two minor instances, completely destroyed by the invasion of locust swarms that began to arrive on January 21st and continued until the middle of February. These crops, prior to being destroyed, were nearing harvest, and were said to be the best the district had possessed for a great many years; especially was this so in the Mwimbi and Chuka divisions. The wheat that was then being grown, approximately 250 acres, was progressing very favourably, and in spite of the shortage of rain, and had the crop not been destroyed, the natives would have made a good harvest. In spite of this crop being, comparatively speaking, only recently introduced and the bad luck which the natives had to endure with regard to its cultivation, namely locusts and drought, it has become very popular and is to be found growing in most locations in the Embu district. The present prospect of the crop, approximately 350 acres, is most encouraging, and it will in the near future be grown extensively throughout the district.

LONG RAIN CROPS.

Maize.

Excellent crops of maize were harvested throughout the greater part of the area under review; especially was this so in the Embu division, where the area cultivated has during the past twelve months increased by at least 75 per cent. Large quantities of good flat white maize seed have been liberally distributed in the area, the seed being supplied by the Agricultural Department, and in consequence the quality of maize that is now found growing in the area is of a high standard.

Mtama.

Grown extensively throughout both districts, but in the Embu division the crop is being replaced by maize.

Beans.

The Canadian Wonder variety, on account of its high yielding capacity and drought resisting powers, has become very popular with the native, and is grown extensively throughout the area under review. Large areas were cultivated during the long rains and good harvests were made, much of the produce being sold for export.

Pigeon Pea.

Extensively cultivated in the Mwimbi division; good harvests were obtained, although not as great as in past years.

Peas.

Grown in a small way, and in most locations, but is rapidly becoming a popular food crop, and its cultivation is bound to increase.

Groundnuts.

This crop has been proved to do well in most locations, but as yet has not received any attention from the native. Its introduction on a large scale is now in hand, and for the forthcoming long rains a total of 334 bags of seed is being distributed in the Embu and South Nyeri districts.

Root Crops.

Every effort has been made and no trouble spared with regard to encouraging the natives to grow more root crops, the chief reason being that root crops are more or less locust-proof, and will grow well in waste swampy land. From observation and information, the area put under cultivation during the year is believed to be far greater than that of any previous years.

English Potatoes.

In the South Nyeri district this crop is grown extensively, whereas in the Embu district it is only just recently that the natives have paid any attention to its cultivation. It is rapidly becoming a very popular food crop, and it is conceivable that in the near future it will be grown on a large scale.

Muhogo.

Considerable attention has been paid to the introduction of this crop into the low-lying areas, where the uncertainty and the shortage of rainfall annually bring about a period of shortage of food. The crop proves to suit most of the Emberre country and, due to the enthusiastic and energetic efforts of the District Commissioner, Mr. Lambert, who on his arrival in the district in March started large muhogo nurseries in and around Embu boma, the natives have been able to acquire unlimited cuttings of this valuable food crop. Over and above what individual natives have acquired for themselves from the nurseries and surrounding plantations, approximately five tons of cuttings were transported and distributed to the natives in the areas affected, while other cuttings have been used to start new nurseries around the Government rest camps.

Yams.

This very popular crop, extensively grown, proves to do best in the high elevations.

Sweet Potatoes.

Extensively grown throughout the area under review.

SHORT RAIN CROPS, 1929.

Excellent weather conditions having prevailed, most of the small grain crops, namely millet, njahi, wheat and chiroko, but not simsim, were able to make good headway and good harvests are now being made. Millet still remains the principal short rain crop grown and, as it has received more attention of late than in previous years, and the area cultivated has considerably increased, it will, when the whole of the crop is harvested, stave off for a considerable period the semi-starvation which the natives have had to endure up to the present.

DEMONSTRATION PLOTS.

As a result of the controversy and the continual trouble that arose over the ownership of the land that was required for these plots, it was found necessary to abandon this branch of work and concentrate on large seed-raising plots situated in central places in the districts; the land used for these was acquired in the Embu and Chuka bomas respectively.

In the South Nyeri district land for this work was leased from the Forest Department. These plots are used solely and entirely for bulking purposes, the produce going to the native for seed. The expenses in connexion with these plots are to be met by the District Local Native Councils and the Agricultural Department.

EXPERIMENTAL PLOT.

Adjoining the Embu seed-raising plot, five acres of land have been set aside and fenced off and are being used for trials and experimental work. In the various small plots the following crops are being grown: Sena rice, edible canna, Niger oil, buckwheat, lucerne, yellow flint maize, six varieties of beans, potatoes, peas and kudzu vine. As this work has only just recently been started, there is at this juncture hardly any data of material value.

SEED DISTRIBUTION.

Embu District.

Wheat, Kenya Governor	...	...	150 bags.
Maize	...	...	1,000 bags.
Groundnuts	...	...	334 bags.

All the above were supplied by the Agricultural Department.

EXPORT RETURNS.
South Nyeri District.

Stations	Sagana	Karatina	Nyeri
Maize	670 tons	1,205 tons	290 tons
Maize Flour ..	1,400 tons	1,022 tons	53 tons
Beans	..	272 tons	53 tons
Potatoes	..	55 tons	3 tons
Hide and Skins ..	20 tons	$\frac{3}{4}$ ton	11 tons
Miscellaneous ..	20 tons	..	..

INSECT PESTS.

Stalk Borer.

Is prevalent throughout the area under review. Instruction and extensive propaganda with regard to the destruction of this pest have been carried out.

Cutworm.

To be found in most locations, but it is not serious.

Locusts.

Innumerable dense large swarms invaded the district from the south-east towards the end of January and again in February, and all the crops were destroyed. Several minor swarms have passed over the district from time to time, but, with the exception of one or two, they all proved migratory, flying in a northerly direction. Hoppers were discovered in Upper Runyengis at the end of May; the infested area was not large or serious, and the matter was successfully dealt with. A large swarm passed over lower Emberre about the middle of November, flying towards Kitui. Laying took place mostly along the Tana River, and a very serious infestation of hoppers began to emerge at the end of November. A campaign was started within the first week in December, and, at the time of writing, the campaign still continues. The staff in the field over and above voluntary labour consists of seven locust officers and 120 labourers. Before expert assistance was available, beating hoppers was carried out daily, and as many as 2,000 people turned out. The method of destruction is now by bran bait. Careful survey of the area proved that approximately 200 square miles were affected with a 20 to 25 per cent infestation. To

cope with the hoppers roads had to be made to various centres, approximately 40 miles of road having to be cut through the bush and rough country.

IMPLEMENTS.

The natives are beginning to acquire ploughs, but their progress in this line is very slow.

HORTICULTURE.

The undermentioned varieties of fruit trees and pine shoots supplied by the Agricultural Department in June were planted at the various Government rest camps in the Embu district, and their progress has been satisfactory :—

Plum	...	...	...	12
Peach	...	...	...	12
Fig	...	...	...	12
Lemon	...	...	...	12
Orange	...	...	...	12
Pine Shoots	...	...	...	60

AFFORESTATION.

To cope with the ever-insistent requests and inquiries relating to tree seed and young trees, it was deemed necessary to start tree nurseries in central positions in the districts to supply young trees to the natives. Four tree nurseries were begun, two in the Embu district, namely Embu boma and Chuka boma, and two in the South Nyeri district, namely Keruguya boma and Murigos. With the exception of the Embu boma tree nursery, which was started early in the year, the remainder have not as yet had time to supply any young trees for distribution. The Embu boma tree nursery has, however, produced approximately 50,000 young trees, consisting of the following varieties, which have been distributed :—

Eucalyptus globulus,
 Eucalyptus saligna,
 Eucalyptus citriodora,
 Jacaranda,

Tecoma; and several varieties of ornamental shrubs.

LIVESTOCK.

In the Lower and Upper Emburri divisions, due to the prevalence of most stock diseases, there have occurred heavy losses among the cattle, sheep and goats. Pleuro-pneumonia and East Coast fever appear to be the most common diseases that affect the cattle, while scab is the chief disease of sheep and goats.

POULTRY.

With the exception of the fowls that are to be found near the Embu and Keruguya bomas, where in the past good Rhode Island Red cockerels were issued to the natives by the Agricultural Department, the stock is very poor throughout the areas under review. To improve the native stock, poultry breeding pens of Rhode Island Red fowls have been started at Embu, and the progress being made is satisfactory. It is hoped to supply young cockerels or eggs to the natives in the near future.

HIDES AND SKINS.

Instruction has been given in curing at all barazas attended, and it is now becoming evident that the natives are beginning to realise the importance of and the advantages to be gained by following out the proper methods of skinning and shade drying.

BUILDINGS.

A maize crib for use in connexion with the seed-raising plot at Embu was erected and completed towards the end of the year; its capacity is for 250 bags of maize. Poultry houses and pens were erected during the period under review.

CONCLUSION.

It is considered that steady progress has been maintained during the past year. The native has applied himself to cultivation with increased activity and his keenness is the more noticeable when it is remembered that much of his work has been lost owing to the ravages of locusts and the lack of rain. Far from becoming apathetic under repeated reverses, he has planted and replanted his shambas, using irrigation during the dry season wherever possible, and the crops standing at the end of the year are expected to give a record harvest. Much of the progress is directly due to the active interest taken in agriculture by the District Commissioner, and I wish to take this opportunity of expressing my thanks to him for his constant help and co-operation.

In the South Nyeri District, steady progress has been maintained during the past year. The native, more fortunate than his Embu brothers, experienced very little, if any, loss from the ravages of locusts.

Relationship with the District Officers has been most satisfactory and their co-operation much appreciated.

A. S. HARTLEY,
Assistant Agricultural Officer.

APPENDIX R.

ANNUAL REPORT OF THE ASSISTANT
AGRICULTURAL OFFICER, FORT HALL,
FOR 1929.

STAFF.

I arrived here for duty on April 4th. Previous to this the district had been supervised by Mr. Hartley, the Agricultural Officer at Embu, since the transference of Mr. Oates to the Coast in August, 1928.

The native staff consisted of five trained instructors.

TRAVELLING.

2,964 miles were travelled by motor car, and 100 nights spent in the Reserve.

WEATHER AND RAINFALL.

The climatic conditions vary very greatly with the altitude which runs from 4,000 feet near Fort Hall up to nearly 8,000 feet towards the Aberdare Range.

The long rains were late, and only lasted a short while. 2.34 inches fell at the station in March, but the rains only really broke on April 23rd, and except for occasional showers stopped after the first week in May. In spite of this crops did fairly well.

The short rains have been the best experienced for many years. They broke the first week in October, and continued right up to the end of the year. Twenty-one inches fell during the last three months of the year. These figures and the table following are the records at Fort Hall, which is only about 4,200 feet. Naturally, much more rain fell at the higher altitudes; in fact, during the last three months the weather has been too cold and wet at altitudes about 7,000 feet and over, resulting in a certain amount of damage by rust in maize and millet.

RAINFALL RECORD, 1929

January ..	2.42	July ..	1.36
February..	0.00	August ..	2.95
March ..	2.34	September	2.12
April ..	8.70	October ..	7.69
May.. ..	3.89	November	6.72
June	.56	December	6.59

Total Rainfall .. 45.34

PRINCIPAL CROPS.

Maize.

This did fairly well during the long rains, although many shambas had to be replanted. The area which suffered most, owing to shortage of rain, was near Fort Hall and towards the Nyeri border. 185 bags of Hickory King were issued in one location, the natives being instructed to plant the issued seed only. The result was very satisfactory, the people being impressed by the obvious superiority of better seed. The general quality of maize grown in the Reserve is undoubtedly improving.

Beans.

These are very extensively cultivated, both during the long and short rains, and a good crop was harvested. The chief varieties are Canadian Wonder and Rose Coco; the former is becoming the most popular, and the general standard of seed in the markets is good.

Millet.

This is the principal short rains crop, and a very good harvest should be reaped throughout the district.

Mtama.

This is grown in fair quantities, and a good crop should be harvested.

English Potatoes.

Extensively grown in the higher areas, and did very well during the long rains. The short rains crop is not good.

Pigeon Pea.

A very good crop was harvested. This is very extensively grown up to about 6,000 feet, and is a very good drought-resisting crop.

Wheat.

Forty bags of Kenya Governor were issued for the long rains. The natives are very slow in taking this up, but a fair amount was planted. Some very good crops were grown on demonstration plots, especially in the higher areas, where it should become an important crop. It is hoped that it will be more extensively grown next year.

Simsim and Groundnuts.

An experimental plot of these was planted at Fort Hall, but gave very poor results, owing to lack of rain. Nuts are so extensively damaged by ground squirrels that it is doubtful if they could be profitably grown here.

TIMBER TREES AND WATTLE.

Wattle.

This is very extensively grown in the higher areas, and the acreage is increasing every year. Large quantities of wattle bark are sold to Indians, and there is also a big trade in firewood.

The natives are very keen on timber trees. There are now three nurseries established, and during the year some 20,000 seedlings were distributed, chiefly varieties of *Eucalyptus*.

FRUIT TREES.

Five orchards of trees were planted in the Reserve, totalling 86 trees, chiefly citrus, plum and peach. A fair number of citrus trees were procured and planted for natives, and there seems to be a growing demand for them.

POULTRY.

Thirty-seven Rhode Island Red cockerels were issued during the year, for which there was great competition. Many natives are keen on improving their stock.

GHEE.

There is no ghee production at present, but it is hoped to start a co-operative industry during 1930.

IMPLEMENTS.

A small mould board plough, harrow and oxen were supplied by the Agricultural Department in September. This has been used for demonstration ploughing in the Reserve, thereby encouraging natives to buy their own ploughs, which will result in increased cultivation and better methods. A few natives in the district already own ploughs.

INSECT PESTS.

Locusts.

Flying swarms visited the district on several occasions during the year, usually passing on after two or three days, and very little damage was done.

Small patches of hoppers were located above Thika on the 26th and 28th May, but these were very quickly dealt with before any appreciable amount of damage was done.

Mealy-bug.

This pest did a great deal of damage to yams, and many plantations were completely destroyed. Formerly it was confined to the southern half of the district, but has now spread right through the Reserve. It also did a little damage to pigeon peas and beans.

Stalk Borer.

Stalk Borer did considerable damage to maize during the long rains in the lower and drier areas. A circular was issued to all Chiefs advising natives to burn all stalks after harvest. Practically none was noticed during the short rains.

SEED ISSUES.

Maize	...	...	...	...	185 bags.
Wheat	...	...	...	...	40 bags.
Beans	...	...	...	...	4 bags.
Simsim	...	...	...	...	1 bag.
Groundnuts	...	...	...	...	1 bag.

EXPORT OF NATIVE PRODUCE, 1929.

FROM THE FOLLOWING STATIONS.

Station	Maize meal	Maize	Beans	Hides	Grain	Wattle bark
	Tons	Tons	Tons	Tons	Tons	Tons
Fort Hall ..	802	143	131	14	110	62
Maragua ..	190	..	686	1	136	2
Punda Milia ..	47	64	8	1	2	..
Thika	1,300	1,228	479	114	..	1,009

GENERAL.

The Local Native Council voted the following sums for 1930 :—

	Sh.	cts.
1. Upkeep of Demonstration Plots ...	2,000	00
2. Purchase of Seed	1,000	00
3. Upkeep of Tree Nurseries ...	960	00
	Sh. 3,960	00

CONCLUSION.

The district as a whole can be said to be very highly developed. The natives are very progressive, and keen on trade. Native methods of cultivation are improving, and most shambas are kept very clean during the growth of the crops, and hoed up to a good depth before planting.

I wish to express my thanks to the Administrative Officers here for their kindly help and co-operation in all ways.

R. FINCH,

Assistant Agricultural Officer.

APPENDIX S.

ANNUAL REPORT OF THE
ASSISTANT AGRICULTURAL OFFICER, MERU,
FOR 1929.

STAFF.

I have been stationed at Meru for the whole year.

At the beginning of the year there were four native agricultural instructors; one was appointed here on the 1st January and another on the 1st February. These six remained unchanged for the rest of the year, and have been stationed—

- 4 in Imende,
- 1 in Tigania,
- 1 in Igembe.

Twelve labourers were engaged in December for work on demonstration plots.

From the 9th February to the 31st July, and again during December, I was attached exclusively to the Administration for work in connexion with famine relief. During the same periods the instructors also spent most of their time on famine work.

TRAVELLING.

I have been away from the district 22 days on leave and 8 days on duty, and away from the station on duty in the district 98 days.

I have travelled 2,273 miles by motor cycle in the district.

CORRESPONDENCE.

Inward, 143 letters; outward, 116 letters.

WEATHER AND RAINFALL.

Long Rains.

Light rain fell in January; February and the first half of March were dry and hot. The long rains broke on the 12th March, but failed badly, 9.48 inches falling from then to the end of June in place of an average of 23.01 inches. Severe drought followed, which was little affected by light rain in July, August and September, during which months the weather was generally cold with the usual frequent mists.

Short Rains.

After light rain at the beginning of October, the short rains (which are here the heavier of the two rains) broke on the 14th of that month, and were exceptionally heavy, over

40 inches falling between that date and the 31st December. This rainfall is by far the greatest on record for the short rains.

Rainfall	1929	Average over 17 years, 1912-1928
	Inches	Inches
January.. ..	2.70	1.68
February	..	1.15
March	2.35	4.49
April	4.43	11.04
May	2.42	6.47
June	0.28	1.01
July	0.73	0.27
August	0.79	0.39
September	1.13	0.70
October	12.43	7.77
November	12.23	12.19
December	15.68	5.03
Total	56.17	52.07

General.

The year has been a hard one for the Meru. The short rains (1928) crops which were well up to average, and almost ready for harvest, were considerably destroyed by locust visitations at the end of January. This immediately started a food shortage which continued with varying intensity for the whole year. The failure of the long rains produced very poor crops, those in many fields being withered before setting grain, and drought prevailed until the middle of October. In addition, further visits of locusts damaged crops which were being raised by irrigation, and the famine which by November was acute maintained its severity until the end of the year. In partial alleviation of distress considerable quantities of food were imported and sold to the natives by Government.

IMPORTS OF FOOD BY GOVERNMENT DURING 1929.

	Maize	Maize flour	Total
	lb.	lb.	lb.
March-July ..	1,658,600	1,582,800	3,241,400
October-December	960,600	11,700	972,300
Total ..	2,619,200	1,594,500	4,213,700

The short rains being heavy during October and November crops made good germination, but the prolongation of abnormally heavy rain with dull weather well into December delayed the maturing of crops in the high altitudes and everywhere made a great growth of weeds, which needed constant attention to keep in check.

CROPS AND CULTIVATION.

As a result of crop failure and destruction, there has been great activity in the shambas this year, especially in the direction of furrow irrigation, under which some maize and large areas of sweet potatoes have been planted. Every available river has been tapped for furrows, and the latter crop has been almost entirely responsible, with the help of Matuma, Vikwa and bananas, for keeping the natives from absolute starvation. This activity has been to a large extent due to the constant exhortations of the District Commissioner, who insisted at all his barazas on the need for irrigation and an increase in cultivation. It is estimated that a 30 per cent increase in the area under cultivation has taken place during the year.

Cereals.

Maize.—As a result partly of natural progress, but mainly of the large seed issues made this year, far more maize is grown now than formerly, and for this latter reason, a great proportion of the maize grown is of good quality. It is hoped that in Igembe, where its cultivation to any extent has only just started, this good quality will be easily maintained. Most of the maize is grown as a half year crop, but in the high cold altitudes it is grown as a nine-month crop, while, where irrigation has been possible, a succession of crops has been raised throughout the year.

Mtama.—This is grown to a large extent as a long rains crop, but gave very poor results this year owing to the drought, the heads being small and badly filled.

Mwere.—This is the most important grain, and is the staple crop of the short rains. That of last year suffered severely from locust attacks. The heavy rains this year caused a good germination, and in the lower parts, especially in Tharaka, rapid and luxuriant growth has been made, and the earliest mwere was reaped in December. In the higher altitudes, the prolonged rain and dull weather has delayed maturity but a good harvest is expected.

Munyaki and Ugimbe.—These are grown in the highlands, but not to any great extent, and their cultivation is slowly decreasing.

Wheat.—Efforts are being made to popularise this crop on the hills, but the year has been unfavourable for propaganda in that direction. It has done very well wherever grown in demonstration plots, and as a result of this its cultivation is being extended.

Pulses.

Many natives are now taking up the cultivation of the Canadian Wonder Beans. Hitherto grown only in the highlands, it is becoming increasingly popular in all parts of the district, except Tharaka, where pulses are not generally grown. It is now one of the Reserve's important crops, this being largely due to seed issues and to the uniformly good results which have been obtained whenever it has been grown in demonstration plots.

Nchavi and Njugu are grown to a large extent, while Nthoroko and Nkinna retain their popularity in the lower altitudes. These native peas and beans produce, under favourable conditions, good yields of high quality, and this year, although results have not been up to average, the Nchavi and Njugu harvests relieved the severity of the food shortage for some time.

English field peas are grown in the cold highlands of Imende, and give good yields there. Trials of it are to be made in Igembe, where the weather conditions on the hills are similar to those of Imende, and where it should produce equally good results.

Hitherto no pulses have been grown in Tharaka, but a small quantity of Nkinna has been planted there in the short rains this year.

Roots.

As has been mentioned above, there has been intense cultivation of sweet potatoes this year. English potatoes are being increasingly grown in the upper parts of Imende, and have been introduced into Igembe, where a demonstration plot is showing great promise.

Yams and Matuma are grown in most areas; Muhogo is grown mainly in Lower Igembe and Tigania, and in small quantities in other parts of the district.

Other Crops.

Bananas, sugar cane and the castor oil plant are grown almost everywhere. Buckwheat has been tried in Tharaka, where a demonstration crop promises a good return and shows a considerably earlier maturity than Mwele.

Simsim has been grown in Imende, and gave a good result at Kaongo. It may be a valuable crop when conditions are suitable for its exploitation. Groundnuts have been tried, but the Meru show no inclination to take up their cultivation.

DEMONSTRATION PLOTS.

The crops of nearly all these plots were destroyed by locusts in January, the harvest of those which escaped being distributed locally for seed. Owing to famine work and disorganisation these plots were not planted during the long rains. In September, work was recommenced on some of them, the remainder being abandoned, and fresh plots were opened up at Igembe, a hitherto untouched area. Some plots in each division were carried on as demonstration and experimental plots, the others being essentially seed-raising plots with, however, considerable demonstrational value.

The distribution of plots at the end of the year was as follows :—

	<i>Imende</i>	<i>Tigania</i>	<i>Igembe</i>	<i>Tharaka</i>	Total
Demonstration Plots ..	5	1	1	1	8
Seed-raising Plots ..	3	3	2	..	8
Total ..	8	4	3	1	16

SEED ISSUES.

Large issues of seed were made during the long rains, as part of the famine relief measures, and further issues were made during September and October. Seed, particularly of the later issues, was in great demand by the natives, whose stores were so greatly diminished by the constant call on them for food, and whose seed when planted was so frequently destroyed by locusts.

The following table indicates the quantities of seed distributed in the district during the year :—

	Long rains	Short rains
Maize	839½ bags	177½ bags
Wheat	5 bags	121½ bags
Mwere	..	* 19½ bags
Beans, Rose Coco ..	260 lb.	..
Beans, Mixed	355 bags	5 bags
Beans, Canadian Wonder ..	..	* 46½ bags
Nchavi	68 bags	..
Peas	260 lb.	..
Buckwheat	..	2 bags
Potatoes	..	* 1,720 lb.

* Those marked with an asterisk were provided from Local Native Council Funds.

PESTS, DISEASES AND VERMIN.

No serious pests or diseases, with the exception of locusts, were observed during the year.

Stalk borer was found in small numbers at Nkubu, and steps were taken to eradicate it, the shamba being completely cleared. Rust (*P. sorghi*) and Cladosporium mould were found on maize and wheat respectively in isolated cases.

LOCUSTS.

Flying swarms invaded all districts in January, and did great damage. Swarms again visited the district in April and repeatedly destroyed the crops in certain areas. Small swarms flew over the district at intervals, one in September destroying some areas of early planted maize in Igembe; a large swarm passed over N. Imende, S. Tigania and Tharaka in October, and a further very large swarm over N. Tigania and Igembe in November.

Laying was reported in Tharaka in October, and hatching in November. An investigation of the extent of the infestation was made in December, and a report submitted.

ELEPHANTS.

Elephants did an exceptional amount of damage to shambas during the middle of the year, trampling and eating large areas of crops in the lower parts of Imende, Tigania and Igembe, and in the upper parts of Imende near the forest.

MARKETS.

Restrictions have been in force under the Famine Ordinance for most of the year, whereby no trader has been allowed to buy food from the natives, either for export or for re-sale to the natives. There has been one prosecution in this connexion.

Native markets have been constantly active, a large part of the sales being to Akamba and Tharaka, who have entered the district in a ceaseless stream in search of food since June. Prices have naturally ruled very high, maize, mtama and similar grains being sold in small quantities at rates equivalent to Sh. 12 to Sh. 20 per load of 60 lb.

In addition to this, however, there has been constant trade in sweet potato cuttings.

SHOWS.

Specimens of cowpeas (Nkinna) and gram (Nthoroko) were sent to the Department for the Agricultural Show at Dar es Salaam, and a sample of cowpeas for the Nakuru Show.

IMPLEMENTS.

The year has been notable for a very marked increase in the use of the jembe in place of the murua, or digging stick. This is particularly so in Imende and Tigania. Traders state that the sale of jembes during the year has been on an unprecedented scale. Moreover, a great proportion of the Moran have been out at work, and have brought back both jembes and an appreciation of their value.

Little interest is shown at present in mechanical tillage implements, owing partly to the unsuitable nature of a large amount of the district and the smallness of shambas, and partly to the great shortage of money this year. One plough and one harrow have been bought during the year.

FORESTRY.

A campaign was started by the Administration for the planting of black wattle in Tigania and Igembe, both near the villages as windbreaks and for fuel and timber supplies, and on the sides of bare hills which are being rapidly denuded owing to lack of sufficient vegetation to stop soil wash. The Local Native Council purchased Sh. 600 worth of seed from Kikuyu, and most of this has been distributed and planted.

Efforts were also made to ensure the planting up with local tree seed of shambas which have been cut out of the forest areas of Tigania.

STOCK.

There have been no verterinary services in the district this year, and no serious disease has been reported.

There has been very considerable trade in sheep and goats to purchase food, but the bottom fell out of the market, as little as Sh. 4 being offered and accepted for a goat.

GHEE.

The new dairy forecasted in last year's report was opened in May on the Morania River on the Meru-Nanyuki Road, but remained open only three months, as drought and famine militated against its activity. It is a permanent building in charge of a trained dairy man and a clerk, and while open was a profitable co-operative undertaking. The following figures show the extent of its business during the three months :—

Total milk received at Dairy	..	..	..	1,484	gls.
Number of contributors	..	..	..	89	
Amount of Ghee manufactured and sold	..	..	..	647	lb.
					Sh. cts.
Price realised at Shs. 1/50 per gal.	..	..	..	970	00
Return to contributors per gallon after deduction of overhead charges	..	..	..	0	59

The dairy has been under the direct supervision of the District Commissioner, and will be re-opened when conditions return to normal, when it is hoped its business will be extended.

CONCLUSION.

It is felt that although this has been a year of severe conditions, it has been one of considerable agricultural progress especially in the direction of the establishment of better crops and of a greater interest in cultivation, and it is hoped that the present crops will give the harvest which they promise, and that next year will be a prosperous one in order that the Meru may be able to maintain this progress and make a further advance in other directions.

Relations with Administrative Officers have been good, and I wish to express my thanks for the constant help and advice given by the District Commissioner.

W. O. SUNMAN,
Assistant Agricultural Officer.

APPENDIX T.

ANNUAL REPORT OF THE
ASSISTANT AGRICULTURAL OFFICER, SOUTH
KAVIRONDO, FOR 1929.

STAFF.

I arrived at Kisii on July 13th from home leave.

One agricultural instructor.

Two instructors arrived from Bukura in September.

One instructor was killed by lightning in September.

An increase in the native staff for next year is desirable in view of the increased activities proposed.

TRAVELLING.

I was on safari for 92 nights, and motored 2,188 miles.

KISII.

Weather and Rainfall.

The long rains started in March and have been continuous since then. 62.65 inches of rain were registered at Kisii Boma for 1929.

Crops.

Maize.—This was sown in the long rains and yielded a crop above the average. The issue of Flat White maize has considerably benefited the quality of the crop in this Reserve. The price obtained was from Sh. 4 to Sh. 6 per bag of 200 lb.

Mtama.—This popular crop has yielded above the average.

Wimbe.—The Wakisii grow a considerable quantity of this crop, it being their staple food. With the exception of two locations where this crop was a partial failure, the yield has been good.

Beans.—The beans sown are of a very mixed type, but a noticeable improvement can be seen owing to the issue of Canadian Wonder seed; this crop will be marketed in the New Year.

Wheat.—600 bags of wheat have been sold by the Wakisii, at prices about Sh. 12 per bag. It is hoped this crop will be more extensively grown in the future. Every endeavour is being made to popularise wheat-growing in the Kisii Highlands, where conditions are very favourable.

Luo.

The crops on the whole have been above the average; the rainfall was about average.

Groundnuts.—The fixing of September 1st for opening the sale of the groundnut season had a beneficial effect on the quality of the nuts sold. The estimated crop sold was about 1,600 to 1,700 tons, the price starting at about Sh. 4/25 per frasila of 36 lb., but falling towards the end of the season to under Sh. 4. The quality of the nuts showed improvement.

Simsim.—There is every prospect that a good crop of simsim will be harvested in the New Year.

Chiroko.—This crop is quite up to average. The short rains have been very favourable, and I think an extended area has been sown.

Maize.—The acreage under maize is increasing, and is becoming more popular with the Luo.

Seed Plots.—Two five-acre seed plot shambas are being started for maize issue, and rice-growing is being tried at some Lake locations.

Noxious Weeds.—Striga is a serious menace in most Luo locations.

Hides and Skins.

Hide bandas have been erected and demonstrations regularly given for the better preparation and drying of hides, but the fall in prices has not encouraged the native to make the extra effort hoped for. A new hide banda has been built since my return from leave.

Dairies.

Dairy-work has been extended during the year; four dairies are now working satisfactorily, and butter for local consumption and ghee for sale are made.

Livestock.

There have been outbreaks of East Coast fever in the Reserve. Grazing has been exceptionally good, and the cattle on the whole look well.

Poultry.

The introduction of pure-bred cocks would be very beneficial in South Kavirondo.

Implements.

The number of ploughs in the Reserve is on the increase.

Insect Pests.

Locusts.—Though locusts visited South Kavirondo during the year, no damage was done.

Conclusion.

The locations on the Tanganyika border have not been visited by me this year.

Progress is being made though, owing to the conservatism of the people, it must necessarily be slow, but throughout the whole area there has been an abundant supply of foodstuffs. The land in the Kisii Highlands is very fertile, and much greater use could be made of this prolific soil.

Great help has always been given me and keen interest taken by the Administrative Officers of this district, whose assistance is greatly appreciated.

C. G. BISHOP,
Assistant Agricultural Officer.

APPENDIX U.

REPORT OF THE AGRICULTURAL OFFICER,
NYANZA, FOR 1929.

STAFF.

Mr. A. G. Bailey, Agricultural Officer, was in charge from the commencement of the year until November 25th, when Mr. W. L. Watt, Agricultural Officer, took over.

Other officers at Bukura were as follows :—

Mr. R. G. Bentall—15th January to 10th September.

Mr. H. L. Bolton—19th April to 16th August.

Mr. E. Cottington—29th September to 31st December.

NATIVE AGRICULTURE—NORTH KAVIRONDO AND
CENTRAL KAVIRONDO.*Crops.*

With the exception of the south-western portion of Central Kavirondo, namely Uyoma, Asembo, Sakwa, and Kadimo, where March-sown crops were only half normal yield, all other areas have been favoured with good rainfall, and crops, both for food and sale, have reaped well.

Food Supplies.

There was no shortage in Kavirondo. Supplies were limited in certain areas, but were corrected by the ordinary course of trade, and no acute trouble was felt.

Supplies from the short rains of 1928 were sufficient for the needs of the population (660,000) to carry them on to June of this year, and in addition a steady traffic in maize to Kisumu was continued. At the end of June supplies were rather short, but regulations prohibiting export to adjoining territories, except under licence, eased the situation. Had regulations not controlled the price at Sh. 13 per bag of 200 lb. demands would have been made for Sh. 16 to Sh. 17 per bag.

Propaganda carried out in 1928, when the outlook was unfavourable owing to locusts and drought, has resulted in an increase of muhogo and sweet potatoes. These crops act as a good standby in dry times.

Weather Conditions.

Only in one corner of the two districts have rains been inadequate, namely the extreme south-west of Central Kavirondo. In the location there, the rains came earlier than usual, and after good showers over a period of a fortnight, which germinated the maize, groundnuts and mtama, they ceased for a month. During the dry spell, much of the groundnut crop died, while the other crops suffered considerably. Elsewhere the rainfall was sufficient. Hail caused some damage in isolated places, but less than was usual in former years.

The rainfall recorded at Bukura, Kakamega and Kisumu was as follows :—

Year	Bukura	Kakamega	Kisumu
	Inches	Inches	Inches
1929	60.28	71.91	33.49
1928	48.29	83.27	43.39
1927	40.60	62.82	35.63
1926	63.85	97.78	49.49

Seed Issues.

The policy of issuing seeds free of charge to natives in selected places for the purpose of assisting output and in establishing more productive varieties of staple crops was continued. The Local Native Council of Central Kavirondo assisted by voting £100 for this purpose.

The following distribution was made :—

	Maize	Peas	Ground-nuts	Carrots	Beans	Gram
	Bags	Value	lb.	Value	Bags	lb.
Central Kav. . .	100	Sh. 45	12,800	Sh. 20	10	450
North Kav. . .	80	..	..	..	..	1,080

There is no question but that the results justify the effort, and it is thought most likely that the Local Native Councils will very considerably increase their votes for this purpose in

future years. By doing so, they will be expected to take a keener interest in seed improvement. Such projects were carried out with considerable difficulty in past years, but results have proved the value to the natives so abundantly that they ask regularly now for new seed.

Again in the case of new and untried crops, even European farmers are conservative, but the natives are much more so.

It is probable, had there been no system of seed issues of maize in the Nyanza Province in the past, that the position during the famine months of August, September and October of this year under review might have been much more difficult to solve.

Crops during Long Rains.

Maize.—During the latter part of the famine period, North and Central Kavirondo provided as much as 8,000 bags of maize a week, which considerably helped the natives in the less fortunate provinces. Much remains to be done in the improvement in quality and yielding capacity of this industry.

Where two crops a year are grown, there will continue to be a difficulty in procuring pure samples of a high grade. A late variety is planted in the long rains, and an early variety in the short rains. While this is quite ideal in theory, it will not work efficiently in Native Reserves, and a high percentage of error is inevitable. Until such time as an all-round short-period variety of maize can be introduced, the likelihood of mixed samples will continue.

The introduction of ploughs into the Provinces in past years and their recent increase in numbers has considerably helped to promote the industry. While the cultivation is an important side of the argument, there is a great deal of education required to eliminate the doubt in the minds of growers about the marketing and fluctuating prices. Though the quantity of maize produced in these Reserves has been very gratifying in the past, there is no reason why the output of surplus grain should not be doubled in the near future.

Much of the produce which was sold was wet and dirty, and this will continue while it pleases the buyers to receive such inferior quality. It is possible that some form of native co-operative trading systems throughout the Reserves, with only progressive natives as members, might cause a decided decrease in the quantity of what is termed "native maize." The term used may be convenient in trade, but is a great hindrance to progress.

The export of Nyanza native maize from Kisumu was 11,726 tons.

In addition, very considerable quantities of maize were consumed at Kisumu by native employees of the Kenya and Uganda Railway, and further quantities were supplied to Uganda and Tanganyika.

1,410 tons of maize were shipped from Lake ports of Central Kavirondo to Kisumu.

Prices to the growers ranged from 20 lb. for Sh. 1 in August to 35 lb. for Sh. 1 in October, namely Sh. 13 and Sh. 9 per bag delivered at Kisumu.

Mtama.—Excellent yields of mtama were reaped, and provided the main staple food for the majority of the population. Mtama flour is more popular than that of maize for food purposes; it is more easily ground, and a better grade of meal can be had.

Groundnuts.—Scanty rainfall from May onwards in the groundnut-growing areas of Central Kavirondo caused very considerable loss, and, as already mentioned, the output was small.

Groundnut Marketing Rules under the Stock and Crop Protection Ordinance were brought into force, and the sale and purchase of the new crop was prohibited before September 1st. Very considerable benefit accrued, and the rules are popular with buyers. It was stated by traders that, whereas in the past as much as 8 per cent of the purchase price was deducted by wholesalers in Europe after examination of the samples, now the loss has been reduced to approximately 3 per cent. Natives continue the practice of extracting the nuts from the husks by beating them with sticks, which results in much of the produce being broken. Efforts are being made to eliminate broken nuts from the samples being sold.

The price of groundnuts at the opening of sales ranged from Sh. 3/75 fair grade to Sh. 4/25 per *frasila* at the end of the year.

Miscellaneous Crops.

Wimbi.—Weather conditions were favourable, and this crop gave very satisfactory results. Though the crop has certain advantages to the growers, it is felt that it ought to be replaced with some crop like wheat.

Beans and Other Legumes.—The present legumes are best suited to the short rains season, and there appears to be a real lack of suitable crop of this nature for the long rains. Pea crops have been tried in several places during the cold rainy months with success. This new crop is most strongly advocated as the balancing agent for the food during part of the year. Gram and njahi have been tried for two years, but are less successful, especially the latter, which has its flowers eaten off by flower-eating beetles.

Muhogo and Sweet Potatoes.—Crops have been satisfactory. The natives are much inclined to neglect the former after it is established, and allow the weeds to grow rampant. Grass fires do damage by passing through the plantations. Yams may be an additional safeguard against drought, but again the plantations are exposed to running fires.

Short Rains Crops.

September—December.

Maize.—Conditions were very favourable for establishing the crops, and the rain continued till the end of the year. The acreage planted was in excess of that for the same period in 1928. These methods of cultivation leave much to be desired, and until that is overcome the yields will be small.

Beans and Pulse.—Crops have been heavy this year. The chiroko crops were most excellent, and will harvest well. These crops are interplanted at random amongst the maize, and cleaning is almost impossible. They have to fight with the weeds and the fittest survive.

There is a great variety of *Phaseolus sp.*, and efforts have been continued to try and eliminate all but Canadian Wonder.

Cowpeas were plentiful in certain areas, and are favoured mostly for the leafage as a vegetable.

Simsim.—This crop is grown chiefly in the drier and hotter areas. This year record harvests have been made on account of the good rain. As a rule cultivation is too shallow for the type of soil and rainfall, but if ploughs become more popular that difficulty will cease. The growers were disturbed by the low prices prevailing at the end of the year. One of the ginneries has established an oil-extracting unit, which will be an advantage to a section of the community.

*Cotton.**Planted June-July, 1928.*

The cotton crop made good growth in 1928, in spite of hail in a few locations.

Buying opened by proclamation on 2nd January but, owing to dissatisfaction with the price, the growers sold little till the end of the month.

Prices ranged from 17 to 19 cents per pound of good seed cotton, and 5 to 8 cents for inferior and dirty cotton (termed "Fifine").

Cultivation was improved considerably, larger areas were planted, spacing was nearer perfect, and higher yields were general.

Total sales of cotton were as shown on Appendix No. 1, and indicate a 60 per cent increase over the 1927-28 crop.

Cotton Crop, 1929-30.—Seed reservation and distribution totalled 190 tons, as shown below:—

Distribution and Issue of Cotton Seed.—Seed was supplied as follows:—

Samia Ginnery	...	...	...	70 tons.
Nambare Ginnery	...	...	...	60 tons.
Malakisi Ginnery	...	...	...	60 tons.

Distribution—

Samia	...	...	...	...	33 tons.
Matayos	...	...	...	...	10 tons.
Busia	...	...	...	...	10 tons.
Marach	...	...	...	...	2 tons.
Andungusi	...	...	...	...	10 tons.
Lukolis	...	...	...	...	25 tons.
Unisatas	...	...	...	...	5 tons.
Nambare	...	...	...	...	25 tons.
Malikisi	...	...	...	...	60 tons.
Lio and Port Victoria	...	...	...	...	10 tons.

Total ... 190 tons

A conservative estimate of 20 per cent increase over the 1928-29 crop was expected, but rains have been unusually heavy and much flower-shedding has resulted; in the Malikisi areas, the bolls at the end of the year were not developing and will be non-productive.

The cultivation in the cotton shambas was of a very high standard. Three native instructors were stationed at Samia, Lukolis and Malikisi respectively.

Grazing, Cattle and Dairying.

The grazing throughout the Reserve should be considered ample for the head of stock. It is mostly of a coarse nature, but the cattle thrive on it. A fair amount of leguminous growth can be seen in the grazing areas, but no clover. Grass fires are too common and are encouraged by the natives for the temporary flush of young growth which follows. They have been discouraged whenever possible.

Most of the cattle around Samia died from disease. The Kavirondo people slaughter a huge head of cattle annually for food purposes, which encourages a higher standard of beasts. Their own supplies are augmented by the purchase of Masai cattle.

Dairying is increasing considerably, especially in Central Kavirondo, and during the year the surplus supplies sold were a tangible factor.

Hides and Skins.

Efforts have been continued to encourage shade drying of hides and skins, but with little result. The Maragoli people have made most progress, and high quality hides were exported from there.

Comparatively speaking, the Kavirondo people are usually very willing to be advised in ways of improvement, but in drying of hides they make no effort to change from their old methods of laying them out in the sun. Encouragement alone is useless for betterment of this industry.

Implements, etc.

There is a general desire on the part of the natives to use labour-saving devices, and the following sales were made from one store in Kisumu where the greatest number of such articles are purchased :—

Separators	...	...	...	...	70
Churns	...	...	...	...	13
Ploughs	...	...	...	...	209
Trek chains	...	...	...	...	521
Yokes	...	...	...	...	142
Ploughshares	...	...	...	...	378
Colonial mills	...	...	...	...	108

Produce Surplus to Local Requirements.

The following produce, most of which was grown in the Nyanza Province, was booked from Kisumu Station :—

					<i>Tons.</i>
Maize	...	...	...	...	11,726
Maize Flour	...	...	...	...	1,079
Beans	...	...	...	...	463
Oils	...	...	...	...	298
Groundnuts	...	...	...	...	154
Rice	...	...	...	...	199
Hides	...	...	...	...	490
Goatskins	...	...	...	...	100

The following produce was shipped from Lake Ports of Central Kavirondo to Kisumu :—

					<i>Tons.</i>
Cotton	...	...	...	...	185
Cotton Seed	...	...	...	...	299
Simsim	...	...	...	...	494
Maize	...	...	...	...	1,410
Maize Flour	...	...	...	...	176
Groundnuts	...	...	...	...	652
Hides	...	...	...	...	88

Plant Pests and Diseases in the Reserves.

Mosaic Disease of Sugar Cane.—Vigorous action was taken in the uprooting of soft-cane varieties. Some Uba has been planted.

Striga Weed.—This parasitic weed is found mostly in Mtama and maize plantations, especially in the lower elevations. Where seen the natives were asked to have it cleaned out immediately, which was done.

Better methods of cultivation and rotation of crops will do much to overcome the trouble.

Locusts.—They did not visit the district.

NATIVE AGRICULTURAL SCHOOL, BUKURA.

Number of boys who finished training in 1929 : 20. Total to date : 42.

The number of apprentices at the school averaged 32 throughout the year. It would have been an advantage to have had larger numbers, but accommodation was limited. This is being overcome in preparation for 1930.

The health of the boys might be considered to have been good, apart from the usual fever and colds. The work is strenuous, when it is considered that the hours of practical work and school are from 6.45 a.m. to 4 p.m. and from 6.30 p.m. to 8 p.m. daily. Much of the difficulty of past years has been overcome in their belief that manual work is to be despised. It was the aim to create a real interest in gaining good crops by modern methods of culture, also to avoid any tendency towards training the boys to become clerks.

The school is divided into three classes to facilitate the teaching of ordinary school and agricultural subjects. This is also an advantage in promoting better distribution of the boys in the different practical operations. Whenever possible senior boys are given control of juniors to assist them to grasp the methods of handling groups of labour.

School subjects embrace: Reading, writing, dictation, geography, hygiene and arithmetic.

Agricultural subjects embrace: Tools and implements and their uses, theory of cultivation, soils, manuring, rotation of crops, botany, seed selection, pests and diseases, crops, trees, surveying, bee-keeping, economics, animal husbandry, etc.

FARM, BUKURA.

The area under cultivation was 62.85 acres. The greater part of this was under Flat White maize. The best quality seed is used for issue to the natives in the Reserves, and the remainder for food purposes. The season was a good one, and crop yields were satisfactory.

Groundnuts.—Variety trials with Shirati, Virginia Bunch, Java White, Jumbo, Spanish Bunch and Butere were laid down. They were still in the ground at the end of December. The soil and climate at Bukura are not too suitable for this crop.

A two-acre plot of pure Shirati was planted and seed will be used for issue in Asembo in 1930.

Lucerne.—Two acres were planted, and made satisfactory growth.

Mtama.—A half-acre variety plot was planted to illustrate segregation of this crop. Natives are too fond of mixing varieties in the field and then separating them after harvest.

English Potatoes.—The following varieties were planted :

Variety	Yield per acre
	Tons
Arran Victory ..	$2\frac{1}{2}$
Ally	$4\frac{1}{10}$
Rhoderic Dhu ..	4
Abundance ..	$2\frac{1}{5}$
Golden Wonder ..	$4\frac{1}{2}$
Great Scott ..	3
Kerr's Pink ..	$1\frac{1}{2}$

Beans.—Canadian Wonder were grown for bulking. Soy beans were tried, but were not successful. Njahi beans : growth was good, but beetles destroyed flowers.

Timber.—Two acres of gum and wattle were planted out.

Grass.—Two acres of Kikuyu grass were laid down and made splendid growth.

Yams.—Some varieties were planted for trial.

W. LYNE WATT,
Agricultural Officer.

APPENDIX No. 1.

STATEMENT OF PURCHASE OF SEED COTTON—
NORTH AND CENTRAL KAVIRONDO.

1928-1929 CROP.

SHOWING INCREASE OF 1928-1929 CROP OVER 1927-1928 CROP.

Messrs. Small & Co., Samia.

Location	1927-28	1928-29	..	Difference
	b.	lb.		lb.
Ginnery, Samia ..	113,056	407,712	plus	294,656
Lukolis	181,459	202,103	"	20,644
Andungusi	34,766	77,178	"	42,412
Unisatas	..	43,021	"	43,021
Busia	61,729	86,701	"	24,972
Matayos	35,746	94,477	"	58,731
Kalite	39,701	114,682	"	74,981
Lukwakwas	32,527	77,814	"	45,287
Marach	13,550	..	minus	13,550
Luambwas	..	15,201	plus	15,201
Totals ..	512,534	1,118,889	plus	606,355

Messrs. Folkes & Co., Nambare.

Location	1927-28	1928-29	..	Difference
	lb.	lb.		lb.
Ginnery, Nambare ..	41,233	12,713	minus	28,550
Matayos	37,916	90,041	plus	32,125
Bisia	84,614	131,093	"	46,479
Andugusi	47,474	80,542	"	33,068
Lukolis	69,705	116,120	"	46,415
Unisatas	52,484	49,976	minus	2,508
Totals ..	353,426	480,485	plus	127,508

B.C.G.A., Malikisi.

Location	1927-28	1928-29	..	Difference
	lb.	lb.		lb.
Ginnery, Malikisi ..	189,922	237,248	plus	47,326
Kalite	194,176	256,162	"	61,962
Lukwakwas	99,422	63,701	minus	35,721
Lukolis	53,627	94,963	plus	41,936
Totals ..	536,547	652,023	plus	115,467

Total Crop 1928-29 = 2,251,388.

Total Crop 1927-28 = 1,402,507.

Increase = 848,881. = 60.5 per cent.

APPENDIX V.**REPORT OF THE ASSISTANT AGRICULTURAL
OFFICER, COAST AREA, FOR 1929.****STAFF.**

I was in charge throughout the year.

The native staff was as follows :—

Mombasa.—One instructor, one apprentice.

Malindi.—Two apprentices.

Kilifi.—Four instructors, seven apprentices.

Digo.—One apprentice.

The staff, as in previous years, was very raw and untrained. Owing to the large area covered by the demonstration shambas, supervision is sometimes difficult; surprise visits often find the shambas dirty and wrongly planted. It is hoped, however, that in the near future training will be given at the Coast Agricultural School. This should bring about a big improvement. Therefore the policy is to persevere with the present staff. Whilst on safari during March and April I was able to give the staff a certain amount of instruction, and since that time I have noticed an improvement in some of the boys.

CORRESPONDENCE.

Inward letters, 418; outward letters, 460.

Correspondence of an advisory nature increased during the year. Several letters were received from Mombasa merchants asking for information as to crops, produce, etc.

WEATHER AND RAINFALL.

1929 opened with a famine in nearly all the Native Reserves on the Coast, due to bad long rains in 1928, and the complete failure of the 1928-29 short rains. January and February were very dry. Heavy rains fell during the last week in March and for about ten days in April. From the end of April until the middle of May was an anxious period; just, however, as it appeared that the crop would again fail, the rains broke and continued, with short intervals, until the end of July.

Around the Kilifi-Sokoke area the rains did not cease for any appreciable time from May until the end of the year. Good short rains fell over all the Coast.

TRAVELLING.

4,162 miles were travelled by motor car. Several foot safaris were made, including one of three weeks' duration up the Coast north of Mambrui on locust destruction work. During March and April a good deal of travelling was done by train between Mombasa and Samburu, distributing seed.

I was on safari 168 days. This would have been considerably augmented but for the fact that I was in hospital for six weeks during May and June.

CROPS.

Maize.

Owing to the excellent rainfall, this crop did very well during both the long and the short rains.

Long Rains.—Famine conditions had, in most cases, prevented the sowing of any maize by the natives for seed purposes. These conditions held in all the Coast districts with the exception of the Sabaki area in Malindi district. To meet the needs of the native, distribution of seed took place in all the Coast districts; altogether nearly 1,000 bags of maize seed were distributed. Big yields were obtained all over the Coast, particularly at Chonyi, and the Sabaki and Uмба River Valleys.

Short Rains.—As a whole the short rains were good, particularly in the back country, where the long rains had been rather light in some places.

Considerable areas were planted, and it was noticeable that in many cases the native went out of his way to get yellow maize seed to plant. Good yields should be obtained in most places, but the maize on the immediate seaboard has dried out. At the beginning of the rains stalk borer seemed to be on the increase, particularly in the Mängea location of Kilifi district. The damage done throughout the long rains did not however, seem to be more than that done last year.

A blight did a good deal of damage in Digo district and in the region around Sokoke. It was identified as a sooty mould.

General.—It can be said that 1929 was a very good year for maize-growing on the Coast. The famine was not entirely an "ill wind," as it was the cause of much good seed being introduced.

The lower end of the Uмба Valley in Digo district was planted with yellow seed, and excellent yields resulted. Weights of yields were taken, and it was seen that in most cases the new seed yielded at least three times as much as the native maize. There is no doubt that the natives were greatly impressed by the heavy yielding and quick cropping maize; in many places people who had no yellow maize to plant for the short rains bought it from their neighbours.

Cotton.

The pickings for the 1928-29 crop were as follows :—

				lb.
A.	...	...	...	157,739
B.	...	...	...	7,479
C.	...	...	...	18,001
Total				183,219

Ginned Cotton—

Bales.		Quality.		lb.
181	...	X	...	53,540
—	...	B	...	3,973
Total				57,513

The percentage of lint was approximately 31. This was an increase of 53 bales over the 1927-28 crop.

Owing to the drought, the staple was very short. The whole crop was, however, remarkably free from pest disease. A campaign for the uprooting and destruction of old cotton plants was started by myself in March. Unfortunately, owing to famine duties elsewhere, I was unable to carry it right through. In most places, however, the work was carried out in a satisfactory manner. Whilst on the work of cleaning shambas, barazas were held, and the people urged to plant more cotton the next year.

1929-30 Crop.—Seed from the first quality 1928-29 crop was kept for distribution, care being taken to see that it was properly stored. The germination percentage was high. Large areas were planted up, and enough rain fell to give the crop a good start. In July, the country around Malindi and Mambrui was a pretty sight with its many cotton fields. During

August and September rather too much rain fell, and some of the first cotton was injured. The damp weather also encouraged stainer. Boll worm, however, never assumed large proportions.

Picking began in September, and by the middle of October people were clamouring to sell their produce. Unfortunately, by this time the cotton market had slumped, and the price was very low. Local prices were eventually fixed at :—

<i>Grade.</i>					<i>Cents.</i>
A.	...	...	...	...	14
B.	...	...	...	...	8
C.	...	...	...	...	5

Buying started November 24th, and by the end of the year approximately 400,000 lb. seed cotton had been purchased. The total crop is estimated at 600,000 lb., which is far bigger than any cotton crop of late years on the Coast.

Coconuts.

There was another big increase in the area of land under coconuts in the Native Reserves, particularly in the Sokoke location of Kilifi district.

It is again apparent that copra production among natives has not increased. In the eyes of the native the coconut palm, in most cases, is regarded as a source from which *tembo* may be derived, with copra as an unimportant and negligible product. Copra production on European estates received a check as the result of the damage done by locusts to Sokoke plantations, the biggest European plantations.

In the region of Gazi, bud-rot also checked production on some estates.

Simsim.

This crop had an excellent year on the Coast. It did well in all districts, and seems to be particularly suited to Coast conditions. It grows into a tall healthy plant and gives a big yield. More natives plant it every year, and during the planting season inquiries for seed are heard everywhere. It would appear to have proved itself thoroughly, and has a big future.

Cassava.

This crop showed its worth during the first half of the year; when there was nothing else left to eat the natives still had cassava to fall back on.

Interest is being taken by Europeans in cassava for the production of power alcohol and flour. It would appear that the crop has a big future on the Coast.

As much time as could be spared has been spent on variety trials, etc., and information has been collected.

Coffee.

The Senior Coffee Officer visited the Coast in September and inspected the coffee growing on various estates. He expressed the opinion that, whilst none of the varieties (Liberica and Robusta) could be said to be a success, a further trial on the good hill soils should be undertaken.

Kunde and Pojo.

Both these crops did well, particularly Kunde. It grows well as a cover crop between young coconuts, and was also tried with success as a cover crop for young sisal. Heavy yields are being obtained from the short rain crops.

PERSONAL WORK.

Digo District.

During 1929 I was able to spend but little time in the native area of Digo district. During March and April I distributed seed from Samburu, Mariakani and Mazeras. Barazas were also held with the idea of teaching proper methods of cultivation and hide demonstrations were given.

Kilifi District.

I spent far more time in Kilifi than in any of the other districts.

It was unfortunate that the intensive planting campaign that had been planned for Chonyi location could not be carried out. Owing to the famine I had to spend March and April buying and distributing food. Most of the districts were visited whilst on safari, and frequent barazas and hide and skin demonstrations were held with, it is feared, little result. Demonstration shambas did well, and were quite efficiently tended. Here again one is led to wonder greatly if they have served any useful purpose. It would appear that for results one has to look to seed issues and location planting campaigns. The result of the seed distribution could be seen everywhere, and natives were delighted with the seed. I think that far more good could be done by seeing that the native plants the issued seed in the right way.

Malindi.

My work in Malindi, apart from two visits to Kakoneni, was almost entirely taken up with cotton and simsim. Barazas on the cultivation of these two crops were frequently held, and, as reported elsewhere, excellent results were obtained.

Coastal Planters.

In 1929 all the big estates on the Coast were visited. On occasion I was able to give useful information as to crops, manures, etc. During the year the Coastal Planters' Association was resuscitated, and monthly meetings are now held. Whenever possible, I have attended meetings, and have reported on the progress of coastal agriculture, particularly with regard to diseases such as bud-rot.

DISEASES AND PESTS.

Cotton.

Platyedra Gossypiella (Pink Boll Worm) was present, but not to any serious degree.

Dysdercus sp. (Cotton Stainer) increased owing to the wet season.

Maize.

In Digo district and in Kilifi, some areas were attacked by sooty mould.

Coconuts.

Bud-rot.—This disease has been present on the Coast for a considerable number of years, and is reported as having done considerable damage in the years 1912-13. In the year under review a good deal of time was spent in the neighbourhood of Gazi, supervising the cutting out of infected trees. That area is now as clean as can be expected.

HIDES AND SKINS.

During the year a considerable number of hides and skins demonstration was given over a large area with, it is feared, little result.

SEED ISSUES.

*Kilifi.**Maize—*

50 bags bought by Agricultural Department.

200 bags bought by Local Native Council.

*Malindi.**Maize—*

75 bags.

25 bought by Agricultural Department.

50 bought by Local Native Council.

*Digo.**Maize—*

25 bags bought by Agricultural Department.

375 bags bought by Local Native Council.

Simsim—

8 bags bought by Agricultural Department.

7 bags bought by Local Native Council.

*Tana River.**Maize—*

10 bags Agricultural Department issue.

40 bags famine relief.

*Lamu.**Maize—*

10 bags Agricultural Department issue.

50 bags famine relief.

Simsim—

12 bags Agricultural Department issue.

Beans were ordered, but owing to the famine up-country were not obtainable.

CONCLUSION.

During 1929 progress was made in most places on the Coast, particularly with the cotton and simsim crops.

Natives showed an interest in better seed and better poultry; unfortunately, there was no corresponding desire to show improved methods of cultivation. It is hoped, however, that the establishment of the Coast experimental farm and training school will see a great improvement.

C. O. OATES,

Assistant Agricultural Officer.

A G R

YA FOR THE YEAR, 1929.

Registered No.		Amount of cloud	RAINFALL.					
			Total amount	Greatest fall	Date	No. of days' rain	Average	Period of years
		0-10	In.	In.		No.	In.	No.
52	1	4.9	40.37	4.02	16th June	83	36.81	22
	1	—	51.03	5.14	18th Apr.	165	—	—
11	1	—	45.03	2.40	6th July	149	43.52	72
233	1	—	48.08	2.40	24th Apr.	167	44.08	7
63	1	7.0	48.97	2.42	27th Apr.	144	44.67	10
53	1	—	44.12	1.76	29th Apr.	163	52.86	22
58	1	3.0	52.69	4.41	8th June	191	61.09	7
33	1	2.7	59.67	1.66	13th Mar.	209	71.53	17
34	1	—	54.35	1.45	18th July	208	70.29	17
189	1	2.3	35.51	1.28	22nd July	162	40.21	11
64								
232	1	7.2	37.91	2.55	27th Apr.	113	36.78	7
27	2	7.0	41.28	2.85	27th Apr.	122	34.25	6
91	1	—	39.44	2.38	27th Apr.	114	34.95	14
	1	—	39.54	2.34	1st May	126	—	—
111	1	—	27.35	1.24	13th July	155	37.09	23

